A Statistical Study of the Learning Ability of Men as it Relates to Age, Education, and Intelligence with Particular Reference to Bookkeeping and Clerical Procedures

By

Arnold E. Schneider, Ph. D.

1946 Delta Pi Epsilon Research Award

Published by
Oklahoma Agricultural and Mechanical College
As a Service to Business Education
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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the University of Michigan.

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FOREWORD

Research in business education is steadily progressing. The number of studies completed each year has increased continuously since 1920. The *Bibliography of Research Studies in Business Education* 1920-1940, sponsored by Delta Pi Epsilon, lists 1,148 studies completed in that twenty-year period. A bibliography of research studies in business education for the period from 1941 to 1948, inclusive, which is now in process of preparation, lists more than 1,200 studies completed in that eight-year period. Obviously, the quantity of research in business education is increasing.

Not only has the quantity of research increased but the range of subjects investigated has broadened. An analysis of the studies completed in the period from 1920 to 1940 shows that the majority of them were concerned with the teaching of business subjects such as bookkeeping, typewriting, and shorthand, and that relatively few dealt with aspects of the broader, general problems and issues of business education such as objectives, administration, supervision, occupational standards, guidance, curriculum building, and general business activities. An analysis of the problems in business education studied between 1941 and 1948, inclusive, shows that the same tendency still prevailed, but that it was less pronounced than in the twenty-year period preceding 1941. Increasing interest has been shown in problem areas such as job analyses and qualifications, production standards in the business occupations, the need for general business education, junior college and collegiate education for business, and business education for adults.

Although the number of research studies in business education has increased and the range of problems investigated has broadened, still more studies need to be made from a wide range of problem areas.

Furthermore, a conscientious effort must be made to improve the quality of research, particularly through better selection and definition of problems, increased adequacy of data and their treatment, careful interpretation of findings, and effective presentation of the report of the research. The usable results of the research studies must not only be made easily accessible to business teachers and administrators but the use that may be made of them in modifying practices in business education must be clearly indicated. Otherwise, many valuable facts and relationships discovered through research will remain in neatly bound theses on library shelves, hidden and unknown to the majority of business teachers and administrators.

In 1941, Delta Pi Epsilon adopted a plan for the recognition of the author of the outstanding research study in business education for the year. The purpose of the plan is to stimulate more research in business education, to encourage the study of a wider range of problems in the field of business

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education, to improve the quality of business education research, and to make the facts and relationships discovered through research more readily available to business teachers and school administrators.

It is with sincere congratulations that the Fraternity honors Dr. Arnold Edward Schneider for having completed the outstanding study in business education in 1946. His study was submitted as the dissertation for the Doctor of Philosophy degree at the University of Michigan in 1946. Dr. Schneider is to be commended on selecting a topic in the field of adult education, a field in which more research needs to be undertaken.

Delta Pi Epsilon expresses its appreciation not only to Oklahoma A. and M. College for publishing Dr. Schneider's study but to the Research Award Committee to which the arduous task of evaluating the research studies submitted for consideration was assigned. The Research Award Committee was composed of H. G. Enterline, chairman; C. K. Reiff; Paul L. Salsgiver; and Lloyd V. Douglas. Robert A. Lowry of the Oklahoma A. and M. College edited the study for publication.

ELVIN S. EYSTER, President

Delta Pi Epsilon

The price of this publication is 60 cents, less discount of ten per cent on orders for ten or more copies. Orders should be addressed to Division of Commerce, Oklahoma A. and M. College, Stillwater, Oklahoma.

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The writer is indebted to his committee, composed of Professors Thomas Diamond, William Clark Trow, Clifford Woody, Paul S. Dwyer, Charles H. Griffitts, and Merwin H. Waterman, for their consideration in permitting the continuation of the problem under special conditions.

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To his wife, Roseann Schneider, the writer owes an eternal debt that all men who work as those in education work owe to their wives.

ARNOLD E. SCHNEIDER

CHAPTER I

THE PROBLEM AND THE LEARNING SITUATION

THE PROBLEM

War creates situations which would rarely be duplicated in civilian life. Ordinarily it would be difficult, if not impossible, to find a hetrogeneous group of men, representing a cross section of the literate, healthy male population, subjected to a highly specialized learning process under a controlled environment. This situation did occur in many of the specialized military training programs.

In the school in which this study was initiated, in 1942, there were men drawn from every conceivable walk of life; men who varied in age from seventeen to forty-nine, in education from seven to twenty years of formal schooling, and in intelligence from slightly below average to very superior. These men were subjected to the identical learning situation under a highly controlled environment. They wore the same kind of clothes, ate the same kind of food, studied in the same classes, used the same study materials, and were sent to bed at the same hour and awakened at the same time. Any curious person would ask, as this investigator asked, "Do the younger men learn with more facility than do the older men?" "Do those with a college education learn more readily than those with only high school training?" "Will an intelligent young man with a high school education have more success in learning the materials of this school than a college graduate with only average intelligence?" These were some of the interesting questions that presented themselves.

In its very inception, the channeling of thousands of men drawn from every phase of our American social, educational, and occupational life into a relatively few highly specialized military tasks presents many interesting educational problems. The writer, in recognition of the possibilities inherent in the many interesting and vital educational problems which presented themselves in this type of situation, began, in the fall of 1942, the systematic collection, recording, and arranging of data which pertained to the men who were being trained at the United States Naval Training School at Toledo, Ohio.

This school specialized in the training of Navy Storekeepers. Navy Storekeepers perform duties that are comparable to the duties of accoun-

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EDITOR'S NOTE: Chapters I through V, as preseneted in this publication, correspond to Chapters III to VII, respectively, in the dissertation manuscript. The first chapter in the manuscript, "Culutral Trends and Adult Education," and the second chapter, "Adult Learning and the Factors which Condition It," have been omitted in this publication. The nature of the content of these two introductory chapters is briefy indicated in the first two paragraphs of the concluding chapter.

The first three tables belong to the omitted chapters of the manuscript. As the tables have not been renumbered, the first one to appear in this publication is Table IV.

Figures 1 through 21, showing graphically the data presented in certain tables, have also been omitted.

tants, bookkeepers, recording clerks, and clerical workers in civilian business and industry. The training area covered by the storekeeping course will be treated in full later in this chapter.

After two years in which preliminary studies were made and the various aspects of the problem were considered, analyzed, and developed, the present statement of the problem evolved:

"A STATISTICAL STUDY OF THE LEARNING ABILITY OF MEN AS IT RELATES TO AGE, EDUCATION, AND INTELLIGENCE WITH PARTICULAR REFERENCE TO BOOKKEEPING AND CLERICAL PROCEDURES."

The early objective of the study was two-fold in nature. As was stated in the introductory paragraph of this chapter, the first objective was born of curiosity. It was to learn, if possible, the answers to some of the following questions:

1. What was the relationship between age and learning ability? Did the older man learn as readily as the younger men?
2. What was the relationship between years of formal schooling and success in learning? Did the men who possessed more formal schooling do significantly better?
3. What was the relationship between native intelligence as measured by a General Classification Test and learning ability? Did those who were natively brighter do consistently better than those who had less native endowment?
4. What was the relationship between recency of education (number of years out of school) and learning ability? Did those who had attended school recently do better than those who had been out of school for a relatively long period of time?
5. What effect, if any, did a previous study of bookkeeping, accounting, or record keeping have on learning a new system of record keeping? Did those who had previously studied business subjects do better than those who had had no training in this area?
6. What was the relationship between the arithmetic achievement level as measured by the Arithmetic Achievement Test and learning ability? Did those who possessed higher arithmetic achievement scores do better than those who were poor in arithmetic?
7. What was the relationship between occupational experience and success in learning? Did those who had significant experience do better than those whose experience was not pertinent to the area of the learning situation?

The second objective of the study was highly utilitarian. It was to determine whether predictive factors exist which would aid in the selection of men who could successfully complete the course of study. It is obvious that this consideration was very important, for the aim of all of the military schools was to train the greatest number of efficient specialists in the least possible time.

Since learning ability expressed by the scores made on the tests was

the criterion for success, a study of either the first or second objective as stated in the preceding paragraphs would yield results which would be identical.

The learning situation for the enrollees provided various kinds of data from which the following were selected as most significant for the purposes of the problem:

1. Age.
2. Formal education.
3. Intelligence
4. Occupational experience.
5. Arithmetic achievement.
6. Recency of educational experience
7. Previous courses in bookkeeping or accounting.

The object of this investigation, therefore, was to determine through statistical analysis the effect of age, formal education, intelligence, occupational experience, arithmetic achievement, and recency of educational experience on success in learning, with particular reference to the vocational occupational fields of bookkeeping and related clerical procedures.

THE NATURE OF THE LEARNING AREA

Naval Storekeeping: In order that a fairly clear idea may be obtained of the kind of learning that was called for, the area of training embraced by the school in which this investigation was conducted will be treated in detail. The Naval Training School at Toledo, Ohio, was a "storekeeper" school. The storekeeping schools were charged with the responsibility of furnishing the trained men for the two major phases of logistics of the Naval Forces afloat and ashore: (1) supply activities and (2) disbursing activities.

Supply activities, with their related bookkeeping and record-keeping requirements, covered the following phases:

A. Incoming	B. Outgoing
a. requisitioning	a. distributing
b. purchasing	b. surveying
c. transferring	c. selling
d. receiving	d. issuing
e. custody	e. transferring
f. inventorying	f. accounting to headquarters
g. storing	

The incoming and outgoing bookkeeping and record-keeping activities covered all naval material, equipment, machinery, provisions, clothing, small stores, munitions, and other items purchased by the government out of appropriations. Each of these areas had to be maintained in terms of al-

lotments and allowances down to the smallest department or activity afloat or ashore.

Disbursing activities, with their related bookkeeping and record-keeping requirements, covered the following phases:

A. Receipt of money
   a. sales of clothing
   b. sales of ship's stores
   c. cash allotment from bureau for payments of personnel and local purchases of goods and services.

B. Payments of money
   a. payroll procedures
   b. personnel pay cards
   c. vouchers
   d. allotments
   e. account current
   f. transportation, personnel and freight

Exact, careful, and legal records for both supply activities and disbursing activities were predicated upon a thorough knowledge of the rules and regulations as well as the exact manner of recording each item on an approved military or governmental form. This is what is often scoffingly referred to as "red tape." Nevertheless, the bookkeeping and record keeping for the supply activities and disbursing activities require a thorough knowledge of myriad rules and regulations.

Elementary bookkeeping and record keeping, as taught in the high schools, evening schools, business colleges, and junior colleges, is concerned, in the main, with the "bookkeeping cycle" and the basic records which make possible the determination of profit and loss and balance sheet reports. The number of records which the student is required to keep in his practice work is very limited. In general, it consists of a general journal, general ledger, and such subsidiary records as the author of the bookkeeping manual may have seen fit to include.

In actual accounting practice, particularly in large firms, a greater number of forms and records is employed. Every department, division, and activity uses many record-keeping forms. The individuals charged with the duty of entering, maintaining, and executing these records, do not, for the most part, have a clear conception of how their work fits in with the entire accounting system of the organization. As far as the record keeper is concerned, the firm is only nterested in having him understand the rules and regulations governing the entries that he will make on the records that are under his jurisdiction.

It is paradoxical, but true, that the more the total accounting knowledge is increased and methods and machines are devised for accurate and detailed record keeping, the more people are employed in strictly detailed record-keeping activities. Of the many individuals who list themselves as "accountants" or "bookkeepers" on the census questionnaire, a great

many are, in actual fact, record keepers doing detailed work under a specific type of accounting system.

Summarizing, it may be said that the course that the men studied in the Naval Training School was a specific type of bookkeeping and record keeping designed for a particular accounting system. The term bookkeeping is retained in the description of the learning activity since a definite cycle of relationships was followed, although this cycle was not patterned after the commonly accepted version of profit and loss and balance sheet relationships. All of the commonly accepted bookkeeping and record-keeping procedures were present, even though the bookkeeping and record keeping were not strictly concerned with profit and loss accounting nor with asset, liability, and proprietorship relationships.

The storekeeper course consisted of two major phases and two minor phases. These were:

Major: (a) Supply accounting and record keeping
(b) Disbursing - monetary receipts and payments
Minor: (a) General Training Course - general naval subject matter - English and Correspondence and Navy Travel Accounting
(b) Typewriting

For the purposes of this study, the criterion was the measure of success attained under (a) and (b) of the major phases. The minor phases are included here to indicate the entire curriculum setting in which the two major phases were studied. The schedule of subjects and time allocations were as follows:

1. Supply Accounting			
(a) General Storekeeping	4	weeks	108 hours
(b) Aviation Accounting	1 2/5	weeks	37 hours
(c) Ship's Store	3/5	weeks	17 hours
(d) Provisions	1	week	27 hours
(e) Clothing and Small Stores	1	week	27 hours
			216 hours
2. Disbursing	8	weeks	216 hours
(a) Payrolls - rules and regulations			
(b) Pay Cards - vouchers			
(c) Allotments			
(d) The Account Current and Supporting Vouchers			
(e) Transportation			
3. General			
(a) General Training Course	4	weeks	20 hours
(b) English and Correspondence	5	weeks	40 hours
(c) Travel Instructions	4	weeks	20 hours
			80 hours

4.	Typewriting Instruction			
	(a) Beginners and Advanced	16	weeks	80 hours
5.	Physical Education			
	(a) All men	16	weeks	80 hours
	SUMMARY:			
	(a) Total hours of instruction			672 hours
	(b) Supervised study periods (evenings)			64 hours
	Total			736 hours
	Total hours per week			46 hours

The method of activating the curriculum in this school varied from the commonly accepted practice found in civilian schools. The administrative technique employed was that of "block instruction" for the two major areas of supply accounting and disbursing. Under this plan, general storekeeping was taught all day for four consecutive weeks. The day was broken up by the introduction of the subjects under points (3), (4), and (5) above.

A trainee's schedule for the day, under this plan, would approximate the following:

0800 - 0900	Typewriting
0900 - 1100	General Storekeeping
1100 - 1200	Physical Education
1300 - 1600	General Storekeeping
1600 - 1700	English and Correspondence
1900 - 2000	Supervised Study

It was a part of the instructional practice to permit the students to study during the regularly scheduled class sessions.

The scope of the course in Supply Accounting was as follows:

1. General Storekeeping
   - (a) Naval Appropriations and Funds
   - (b) Stock Classification and Nomenclature
   - (c) Methods of Procurement, Requisition, Purchase, and Transfer
   - (d) Stock record
   - (e) Stock upkeep
   - (f) Surveys (methods of writing off losses)
   - (g) Returns (reports to main office - Bureau of Supplies and Accounts)
2. Aviation Accounting
   - (a) Plane and Engine Parts - nomenclature and classification
   - (b) Stock records
   - (c) Special reports - parachute reports, issuance of cross country materials, survey of engines, etc.
   - (d) Returns
3. Clothing and Small Stores - Ship's Stores
   - (a) Procurement
   - (b) Reports and Records
   - (c) Issues, Sales, Surveys
   - (d) Returns

4. Provisions
   (a) The Navy Ration
   (b) Procurement
   (c) Issues, Sales and Surveys
   (d) The Ration Record
   (e) Stock Records and Upkeep
   (f) Returns

The course in Supply Accounting outlined above was distinctly vocational in character and combined lectures with practical work. Basically, each sub-course consisted of a practical problem in which it was assumed that the student "opened" a supply office on the first of a given quarter and simulated the various transactions of requisitions, purchase, transfer, issue, and survey normally encountered in the operation of a supply office. The course in Disbursing was based on the actual disbursing problems encountered in a disbursing office and was highly vocational and pertinent to the actual work performed in practice.

In order to further define the area of storekeeper training, a resume of the accounting, bookkeeping, and recording activities of a representative hypothetical naval station is presented:

1. Purchasing
2. Storing
3. Selling - cash sales - clothing and small stores
   cash sales - ship's stores
4. Disbursing funds
   (a) paying personnel - pay records
   (b) mileage vouchers
   (c) payment of provisions bills
   (d) charging pay accounts with allotments
   (e) issuing public vouchers for payment
5. Commissary records
6. Consumable supplies - records and inventories
7. Equipment - records and inventories
8. Procurement, requisitioning, issuing, and transferring of naval stores and equipment
9. Correspondence

A review of the preceding list illustrates the point that the Navy accounting, bookkeeping, recording activities, under the general term of "storekeeping" covers, for all practical purposes, all of the accounting, bookkeeping, and recording activities found in a normal business enterprise in civilian life. It is the application of a specific and rigid set of rules and regulations to its record keeping activities which differentiates Naval business practices from those found in everyday civilian life.

It must be noted, however, that Navy recording activities, because of the very nature of the rules and regulations, embrace a system that is

entirely foreign to practices as commonly found in civilian life, although the end to be obtained is the same for both.

Still another aspect of the areas of training required in order to produce competent storekeepers can be gained by a study of the qualifications requirements for duty as a storekeeper as published in the Bureau of Naval Personnel Manual. Since this material is relatively detailed, it is presented in Appendix A.

Summarizing, it may be said that the storekeeper school attempted to train a man, in an intensive four months' period, to master an entire bookkeeping or record-keeping system. It cannot be too strongly emphasized that there was nothing in the Naval system of bookkeeping or record-keeping that could be directly likened to any accounting or bookkeeping practice as conducted or taught in civilian life. This point is emphasized because the study is predicated upon the facts that none of the trainees in the study had had any prior training in the area, and that any differences that existed, such as formal schooling, intelligence, age, courses in bookkeeping or accounting, or occupational experience, are accounted for in the study.

THE INSTRUCTIONAL CLIMATE

The learning situation in this study was unique. It was, for all practical purposes, a controlled environment. This is a vitally important point, since many writers and investigators in the field of educational psychology have pointed out that the environmental conditions which may be present in a learning study and which are not reported as a part of the study, may be, in fact, greater determinants of the results than the actual data employed to determine the outcomes.

Because of the military nature of the school, the learning took place in an environment that was controlled to an extent which is not attainable in normal civilian situations. The school itself was conducted in a Naval Armory which was built on a small peninsula jutting into the mouth of the Maumee River where it flows into Lake Erie. The men in attendance were isolated from all of the distracting elements of stores, traffic, movies, and other concomitants of civilization.

It is very important to note that no other activity was in progress at this training station except that of the learning situation which is the subject of this study. As military training schools go, or, for that matter, in comparison with most schools, the institution was small and ideally isolated, devoting itself entirely to training in one specialized area. All the efforts of the school were directed towards one end, that of producing the most efficiently trained men in the time allotted. This singleness of pur-

pose was one of the important contributing factors towards producing a homogeneous learning climate.

The impression must not be gained that this was an "ideal" learning situation. It was controlled and it was homogeneous, but in terms of good school practice it was not an "ideal" situation. The classes were large, the classrooms were small, inadequately ventilated, and, in general terms, the accommodations could be classed as only "fair." It is true that many of our high schools and small colleges do not possess better facilities, but this does not alter the fact that, in general, the teaching and learning conditions of this study were far from normal or adequate in a physical sense.

In order to specifically define the limits of the environmental controls, they are listed below:

1. School attendance
2. Study requirements
3. Sleeping hours and sleeping accommodations
4. Recreational hours and privileges
5. Liberty (absence from station and duty)
6. Food and hours of serving meals
7. Medical attention
8. Clothes
9. Course of study and study materials
10. Equipment

Since the meaning of each of these controls is fairly obvious, it is not necessary to present a detailed explanation. The total effect of this controlled environment was to remove from the individual the variations of daily life to which each would be subjected if he were in a civilian status. It is a well recognized fact that although our students in school are subjected to the same objective environmental conditions while they are in the classroom, the variations in their home conditions, in their sleep habits, in their nutritional opportunities, and in other factors of a similar nature tend to make them heterogeneous rather than homogeneous learning groups. These variations, which are ever present in adolescent groups in the schoolroom, become even more marked among adult learners.

It may be said that the individual in service lost certain responsibilities which, if he were mature, he had carried for some time. He no longer was responsible for selecting the clothes he would wear, the food he preferred to eat, the hour when he chose to go to bed, the time he got up in the morning, or when he would enjoy his leisure hours. The program for the group was rigid and did not readily admit of any changes or deviations for the individual. A copy of the daily "Work Sheet," which outlined the plan of the day, is presented in Appendix B. An examination of this "Work Sheet" will help to clarify the manner in which some of the controls operated.

It would be a fatal error and an unwarranted assumption to conclude

that since the environment of the learner was controlled, each individual was, ipso facto, removed from all other conditions which would influence his thinking and his actions. There were a number of factors that probably could and did readily disturb the individual in this controlled environment. The very nature of the learning situation itself, in which the individuals were subjected to an intense learning period, was fraught with mental hygiene and behavior problems.

A resume of the factors that probably affected the controlled environment would include:

1. Worry about home problems - wives or children.
2. Worry about monetary affairs.
3. Feelings of insecurity in the military situation.
4. Inability to reconcile one's self to the impartial military life.
5. Feelings of resentment at real or imagined "unjust" treatment at the hands of officers or petty officers.
6. Dissatisfaction with the area of training to which assigned.

Each of the preceding points was, insofar as each individual was concerned, a subjective judgment. For this reason, no attempt was made to determine what effect these subjective factors might have on the learner in the learning situation. While it is true that occasionally an individual would make known his difficulties to the chaplain or to a school officer, this was a relatively rare occurrence.

Before leaving the topic of the controlled learning situation, it would be well to discuss in detail one particular aspect, that of reward and punishment as incentives to learn. It would be apropos at this point to review Ruch's[1] summary of the major difficulties which present themselves in conductiing research studies on the learning ability of adults. We need concern ourselves here with only one of the three most frequently encountered methodological problems which he listed. This problem is, "to obtain the same degree of motivation throughout the entire age range".

The reward and punishment incentives used in this learning situation were unique in comparison with civilian techniques ordinarily obtaining in similar situations. They were direct, immediate, and forceful:

Punishment: Failure in a weekly examination meant loss of liberty for Wednesday night and the following weekend. It meant enforced supervised study during this period of loss of liberty. Three consecutive failures resulted in dismissal from the school and assignment to general duty with its concomitant loss of privilege to attend another service school.

Reward: The top fifty percent of the graduating class were rated (promoted to) petty officer, third class. This meant an increase in status, pay, and privileges. It also carried the implication of a better duty assignment. All of the trainees who

1 Floyd L. Ruch, "Adult Learning," *Psychological Bulletin*, Vol. 30, No. 6, June 1933, pp. 387-414.

made a grade of "75" (62 was the lowest passing grade) were promoted to seaman, second class. This represented an increase in grade and pay.

A bare statement concerning the reward and punishment incentives used in the learning situation of this study does not adequately describe their efficacy. One would have had to have lived in the atmosphere—to have been a part of this system—in order fully to appreciate the intensity with which the reward and punishment conditions were applied. For better or for worse, these two main incentives, the one of reward and the other of punishment, acted with unusual vigor for all but a very few of the many thousands of men who passed through the training program.

The total enrollment of the school was set at a maximum of eight hundred men. During the period covered by this study the enrollment stayed at the maximum figure. A "draft" of two hundred men was received monthly. A corresponding number (two hundred, less those who fell by the wayside) were graduated each month. There was a complete turnover every four months. It follows that the number of students that could be processed during a calendar year was twenty-four hundred.

Each "draft" of two hundred men, as it was received, was divided into four divisions of fifty men each. Each division became a "class" for instructional purposes. Theoretically, therefore, all classes were composed of fifty men. The actual enrollment varied from this figure because of illness and because the men were given permission to go home if a death or serious illness occurred in their immediate family. Failures also contributed to class enrollment losses. Men who returned to active duty after a leave or an illness were assigned to a class into which they could fit. Because of these factors affecting the class enrollments, the actual size of classes might range from forty-two to fifty-five. Under the circumstances, which will be described in subsequent paragraphs, these classes were too large for the most efficient instruction.

It is difficult to describe the classrooms, as they were not originally built for the purposes for which they were used during the emergency. Among their shortcomings may be listed:

1. The rooms were too small to comfortably seat the number of men who were assigned to them.
2. The classroom seating equipment was unsatisfactory for adequate teaching. The tablet chairs provided did not prove suitable for the workbook type of teaching that was used throughout the school. The blackboard space was decidedly limited in most of the rooms.
3. The ventilation was poor. Although many of the rooms were on the outside and could receive direct ventilation, nevertheless it was necessary to equip the rooms with blowers in order that a sufficient amount of air could be introduced into the rooms. These blowers were noisy and added to the teaching problems. A number of the rooms received no direct ventilation. These rooms were unbearably warm during the summer months.

4. The lighting was poor. The lighting fixtures were not suitable for classroom work. Many of the rooms were inside rooms and had no daylight.
5. There were no adequate study halls. Study hours during the day, and also for a large share of the evening study groups, were conducted under very trying and handicapping situations.

Summarizing, it may be said that the classrooms and study halls were makeshift arrangements and were not conducive to the best type of teaching and learning situation.

MATERIALS AND METHODS OF INSTRUCTION

The trainees were provided with specially prepared multilithed copies of a "training course." this course was, in fact, a textbook-workbook combination. It contained the essence of the basic rules and regulations governing a particular transaction or series of transactions, with accompanying instructions for executing the blank forms and other simulated media that were a part of the book.

Each instructional area had its own specially prepared workbook or training manual. Those experts in the field of teaching who had the opportunity to examine these materials ventured the opinion that these were unique teaching aids and particularly adaptable to this particular type of instructional area.

In addition to the workbooks, there were a number of basic reference manuals with which the trainee was required to become familiar. The reference manuals were, for the most part, couched in military and governmental terms and in many instances were difficult to interpret.

The classes were conducted on a lecture supervised laboratory basis. The manner in which this program was conducted was as follows:

1. The instructor, following a very carefully prepared outline which was synchronized with the 'workbook training course,' presented a lecture covering the salient features of the topic that was being presented.
2. Upon completion of the lecture period, the trainees immediately turned to their 'workbook training course' and carefully followed the detailed instructions for working the simulated actual problems.
3. The principles presented in the lecture and executed in the 'workbook training course' were annotated in order that the trainee might refer to the basic reference manuals in order to completely integrate the principles and the application of the principles in problem situations.

It may be said, in passing, that the classroom recitation technique was rarely employed. However, if any trainee raised a question, it was promptly and courteously answered by the instructor. As a rule, questions were not encouraged until after the trainee had attempted to work the practical problems.

CHAPTER II

THE DATA EMPLOYED TO MEASURE LEARNING ABILITY

The assignment of men to the various specialized training programs was under the jurisdiction of the Selection and Classification departments of the Basic Training Activities, such as Great Lakes. When the men were received at the specialized school, such as the school in which this study was conducted, they had already completed a twelve-week basic or "boot" training. During the "boot" camp period the men were subjected to a battery of tests and, in addition, each man was interviewed by trained classification specialists in order to obtain personal data for the permanent record. The score the man made on his basic battery and the information elicited by the classification interviewer were entered on a "Qualifications Card." This Qualifications Card was made a part of the permanent service record of each man and was sent with him whenever and wherever he was transferred.

On the basis of the information entered on the Qualifications Card, the Classification Specialist would indicate the various areas of specialized training for which the man was qualified. This method assured a theoretical compliance with the best practices of selecting the right man for training in a particular field. In actual practice, however, the conditions obtained were often far from ideal and not in conformity with the expressed aim of selecting the right man for the right job. Under pressure of large numbers and immediate needs, the men were often assigned on an exigency basis rather than upon the basis of scientific measures that were at hand. In addition, the needs of the services were continually changing, forcing the Selection and Classification departments to revise school quotas and assignments. Specifically speaking, if a man were well qualified for training in the storekeeping areas, there would have to be a storekeeping training program in progress in order for him to be assigned to this area; otherwise, he would be assigned to another area.

PROCUREMENT OF THE RAW DATA

The Qualifications Card is not shown in this study because this form is carried under the security rules of the Navy as "Restricted." A very similar record is, however, included. This is the "Personnel Data Sheet" which was designed, in part, by this investigator. This data sheet was used at the Naval Training School in which this study was undertaken and was used as the school's permanent record of the trainee. Much of the information that appeared on the Qualifications Card and which was applicable to this study also appeared on the Personnel Data Sheet. A photostatic copy

of the Personnel Data Sheet is shown in Appendix C. The Personnel Data Sheet was executed by the subjects in this study under the direct supervision of this investigator. The cards were filled in by the men in groups of fifty. Wherever the same information appeared on both the Navy Qualifications Card and the Personnel Data Sheet, a careful check was made in order to verify the accuracy of the information. In case of any discrepancy, the man was called in by the investigator and interviewed.

Each of the factors studied in this investigation was, then, obtained from the following record or records:

1. General Classification Test Scores. This information was obtained from the Qualifications Card.
2. Years of Formal Schooling. This information was taken from the Qualifications Card and checked against the Personnel Data Sheet.
3. Age. This was taken from the Personnel Data Sheet and checked against the Qualifications Card.
4. Occupational Experience Classification. This information was taken from the Qualifications Card and checked against the Personnel Data Sheet. This item was carefully checked on both records in order to obtain an accurate appraisal of the subject's occupational experience.
5. Business Students vs Non-Business Students. This information was taken from the Qualifications Card and checked against the Personnel Data Sheet. This item was carefully checked on both records in order to obtain accurate information on the business courses the man might have previously studied.
6. Arithmetic Achievement Test Scores. This information was obtained from the Qualifications Card.
7. Recency of Educational Experience. This information was taken from the Qualifications Card and checked against the Personnel Data Sheet. This item was carefully checked on both records in order to obtain as accurate information as possible on the number of years that the subject had been out of school.
8. Criterion Scores. This information was taken from the reverse side of the Personnel Data Sheet, which was labeled "Permanent Grade Records." An explanation of the score which the grade record represented is given under the explanation of Criterion Scores.

The work of collecting and recording the raw data on the factors listed above was continued over a period of approximately two years.

GROUPING OF THE DATA FOR STUDY

As the men completed the course of training, and as data on their achievement were collected, several preliminary studies were undertaken. The number of cases in relation to each factor in these preliminary studies was as follows:

Factor Studied	*Number of cases*
GCT Scores	1576
Arithmetic Test Scores	1576
Formal Schooling	1983
Age	1983
Occupational Experience	1983

Studies were also undertaken with various sized groups to determine the relationship of failures to the factors.

After the data for the total number of cases reported on in this study had been recorded, it was decided to divide the data into two groups: Group A and Group B. The basis for the distinction between the two groups stems from the following facts:

1. Data on Arithmetic Achievement Test Scores were available for Group A and not for Group B.
2. Data on Recency of Educational Experience were available for Group B and not for Group A.

Group A comprised the first 1774 cases as they were enrolled in the school. Group B comprised the last 1360 cases as they were enrolled in the school. The two groups were alike in all other respects and, except where otherwise stated, may be treated as a homogeneous group for the purposes of this study.

AGE

The age of the enrollees is given in Table IV. It is presented in terms of the number of men at each age who were included in the study and the percentage of the total that this age level represented. The range of ages, under the circumstances, quite naturally followed the age limits set by the draft laws. The seventeen-year-old group represented those who had enlisted with the permission of their guardians. The Navy, throughout the entire war, followed its peacetime tradition of accepting seventeen-year-olds for duty. Those who were beyond forty were also, generally, voluntary enlistees. The bulk of the men, those who fell between eighteen and thirty-nine, represented a cross section of the healthy male population subjected to the draft laws. It will be noted that Group A contained over fifty percent in the eighteen to twenty-one (inclusive) age levels. This is a reflection of the fact that the statistics for this group were gathered during the first years of the war (1942-1943), and the pressure on the older members of the male population to enter the services was not as yet strong.

It will also be noticed from Table IV that, as the war progressed, older men were assigned to this learning situation. Group B has a strong representation in the twenty-five to thirty-five (inclusive) age levels. This older group comprised approximately fifty-five percent of the 1360 men in Group B.

TABLE IV
AGE OF THE MEN*

Age	GROUP A		GROUP B		TOTAL	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
17	74	4.20	25	1.84	99	3.16
18	271	15.27	217	15.96	488	15.60
19	280	15.78	83	6.10	363	11.58
20	274	15.44	34	2.50	308	9.82
21	110	6.25	38	2.79	148	4.72
22	72	4.05	35	2.57	107	3.45
23	39	2.20	30	2.20	69	2.20
24	38	2.14	39	2.87	77	2.45
25	40	2.25	42	3.08	82	2.65
26	56	3.15	54	3.97	110	3.50
27	56	3.15	60	4.41	116	3.70
28	59	3.32	82	6.02	141	4.50
29	57	3.21	80	5.88	137	4.39
30	37	2.08	77	5.66	114	3.63
31	42	2.40	71	5.25	113	3.60
32	46	2.60	65	4.78	111	3.54
33	39	2.20	70	5.15	109	3.48
34	46	2.60	57	4.19	103	3.28
35	38	2.14	78	5.75	116	3.70
36	27	1.52	49	3.60	76	2.42
37	18	1.01	54	3.97	72	2.30
38	11	.62	19	1.39	30	.95
39	5	.28	1	.07	6	.19
40	15	.85			15	.48
41	5	.28			5	.16
42	6	.33			6	.19
43	6	.33			6	.19
44	3	.16			3	.10
45	1	.05			1	.03
46	1	.05			1	.03
48	1	.05			1	.03
49	1	.05			1	.03
Total	1774	100.00	1360	100.00	3134	100.00
Mean	23.60		26.88		25.01	
S. D.	6.34		6.45		6.59	

* For the purpose of this study the age considered was the age of the man on his last birthday.

YEARS OF FORMAL SCHOOLING

Table V presents the number of years of formal schooling possessed by the men in the study.

The Personnel Data Sheet, Appendix C, shows how this information was obtained from the subjects. The number of years of school attendance was not used as the sole criterion for judging whether a person had graduated from high school or college. It will be noticed that a direct

question was asked as to whether the subject had received a diploma or degree signifying completion of the course.

It was found that men who came from the Southern States and who had graduated from high school possessed only eleven years of formal training. Because their high school graduation was comparable to high school graduation in communities which require twelve formal years to complete this training, the relatively few cases that fell in this category were credited with twelve years of formal schooling.

A breakdown accompanying Table V gives the number and percentage of the men who possessed college degrees; the number and percentage of the men who had attended college for various lengths of time but who had not graduated; the number and percentage of the men who had graduated from high school; and the number and percentage of the men who had less than a high school education. The number and percentage who had more than a high school education were approximately the same as for those who had less than a high school education.

TABLE V

YEARS OF FORMAL SCHOOLING

No. of Years	GROUP A		GROUP B		TOTAL	
	Number	*Precent*	*Number*	*Percent*	*Number*	*Perecnt*
20			1	.07	1	.03
19	1	.06	6	.44	7	.22
18	4	.23	6	.44	10	.32
17	19	1.07	9	.66	28	.89
16	49	2.76	69	5.07	118	3.74
15	44	2.48	58	4.26	102	3.25
14	107	6.03	89	6.56	196	6.25
13	201	11.33	114	8.38	315	10.05
12	927	52.25	687	50.52	1614	51.50
11	189	10.65	132	9.70	321	10.25
10	142	8.00	104	7.65	246	7.85
9	53	2.99	49	3.60	102	3.25
8	34	1.92	31	2.28	65	2.08
7	4	.23	5	.37	9	.29
Total	1774	100.00	1360	100.00	3134	100.00
Mean	12.05		12.17		12.10	
S. D.	1.61		1.84		1.69	

BREAKDOWN

Classification	*Number*	*Percent*
College graduates or better - - -	164	5.20
13 to 15 years of schooling - - -	613	19.55
High school graduates (12 years) - -	1614	51.50
Less than 12 years - - - - -	743	23.75

INTELLIGENCE

The intelligence of the men in the study was measured by an examination developed by the psychologists attached to the Test and Research Division of the Bureau of Naval Personnel. This examination was labeled "The General Classification Test" and was referred to by its initials, "GCT."

According to one Navy psychologist[1] who worked with the test, the General Classification Test "is really a test of ability in abstract reasoning —close to an intelligence test. It isn't as broad as an intelligence test should be because we use it for differential classification."

The test was administered as a part of the Navy Basic Battery by the Selection and Classification Department at each of the Basic Naval Training Stations while the men were undergoing their "boot" training. It generally was administered to all of the recruits two weeks after induction into the military system. Because this test is classified as "Restricted" by the Bureau of Naval Personnel, a copy is not included in the appendices.

In order to make the test results more meaningful to all of the Navy officers charged with the duty of assigning men to duty afloat and ashore, the General Classification Test scores were converted into standard scores. This was done on the basis of an adequate sampling of raw scores obtained from the General Classification Test results. The standard scores, or "T" scores, were calculated from the mean or average score in conformity with a normal distribution of ability. A GCT standard score is, then, one which by definition has a mean score of fifty and a standard deviation of ten.

This means that the average standard score of every test was fifty and that approximately fifty percent of the men taking the test received a score of less than a standard score of fifty and that approximately fifty percent of the men received a standard score of greater than fifty. Approximately sixteen percent of the men received a standard score of sixty or better and approximately sixteen percent of the men received a standard score of forty or less.

Table VI interprets further the significance of standard scores in relation to the raw scores obtained from the General Classification Tests. A standard score of fifty is just "average." Men with scores of from forty-five to fifty-four, inclusive, are in the middle one-third. Standard scores from fifty-five to sixty-four are considered as "substantially above average" and scores from thirty-five to forty-four as "substantially below average"; one-fourth of all the men tested fall in each of these two categories.

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1 Guy L. Bond, in *Swords into Ploughshares*, A publication of the Superintendent of Public Instruction. The State of Michigan, Lansing. 1946, p. 19.

Scores above sixty-five are "high" and scores below thirty-five are "low." About one-twelfth of all the men tested fall in each of these two categories.

TABLE VI

STANDARD SCORES, RAW SCORES, AND THE APPROXIMATE DISTRIBUTION OF MEN INTO THE VARIOUS SCORE CATEGORIES

Rating	*Standard Score*	*Raw Score*	*Approximate proportion of men falling in each category*
High	65 to 79	91 to 99	one-twelfth
Substantially Above Average	55 to 64	80 to 90	one-fourth
About Average	45 to 54	65 to 79	one-third
Substantially Below Average	35 to 44	49 to 64	one-fourth
Low	0 to 34	10 to 48	one-twelfth

Originally the tests were scored on a raw score basis with 99 as the highest possible score. Because the standard score adaptation was not made until late in 1943, the investigator continued to use the raw score rather than the standard score for recording the General Classification Test scores of the men in the study. However, a conversion table was prepared for those working with the raw scores so that raw scores could be read as standard scores for the test results and vice versa. It is hoped that its presentation will help to clarify all references to raw score and standard score for the General Classification Test.

TABLE VII

CONVERSION OF RAW SCORES TO STANDARD SCORES GENERAL CLASSIFICATION TESTS

Raw Score	*Standard Score*	*Raw Score*	*Standard Score*	*Raw Score*	*Standard Score*
99	79	69	48	39	28
98	77	68	47	38	28
97	75	67	46	37	27
96	73	66	46	36	26
95	70	65	45	35	25
94	68	64	44	34	25
93	67	63	43	33	24
92	66	62	43	32	23
91	65	61	43	31	23
90	64	60	42	30	22
89	62	59	41	29	21
88	61	58	41	28	21
87	59	57	40	27	20
86	59	56	39	26	20
85	58	55	38	25	19
84	58	54	38	24	18
83	57	53	37	23	18
82	56	52	36	22	17
81	56	51	36	21	16
80	55	50	36	20	15
79	54	49	35	19	15
78	54	48	34	18	14
77	53	47	33	17	14
76	52	46	33	16	13
75	51	45	32	15	13
74	51	44	31	14	12
73	51	43	31	13	11
72	50	42	30	12	
71	49	41	29	11	
70	49	40	28	10	

Table IX presents the number and percentage of the men who scored, in terms of raw scores, at various levels on the General Classification Test. It will be noted from this table that the men in this study represented a select group insofar as their intelligence was concerned. This premise is based on the standard score distribution of the total men in the Naval service into the various categories, as presented in Table VI. The data in Table IX, when arranged in accordance with the distribution as outlined

in Table VI, show that the men in the study fell into the score categories as shown in Table VIII.

TABLE VIII

A COMPARISON OF THE MEN IN THE STUDY WITH THE STANDARD SCORE DISTRIBUTION OF THE TOTAL POPULATION FROM WHICH THEY WERE DRAWN

Raw Score	*Rating*	*Number of Men in This Study*	*Percent*	*Percent Falling in This Class Total Population*
91-99	High	649	20.67	8
80-90	Substantially above average	1482	47.29	25
65-79	About average	894	28.58	33
49-64	Substantially below average	106	3.37	25
10-48	Low	3	.09	8
	Total	3134	100.00	100

It will be noted from Table VIII that the only group in this study which approached the same distribution as found in the total population was the "about average" group. There was a twelve percent greater representation in the "high" group; twenty-two percent greater representation in the "above average" group; twenty-one percent smaller representation in the "below average" group; and seven percent smaller representation in the "low" group than that found in the distribution of test scores for the total men in the Naval service. This emphasizes the fact that the men in this study were, insofar as intelligence is concerned, a select group who, according to psychological measurements, were highly capable of learning.

It is conceivable that many of the men did not make their best possible scores on the General Classification Test. The test was administered during their "boot" camp days. Certain adjustments were being made during this period of time which would preclude their being at their most efficient peak. On the other hand, the majority opinion of psychologists would lead us to believe that those with the most intelligence would have the tendency to adjust the most quickly.

The physical surroundings at the time the tests were administered were, psychologically speaking, open to question as being conducive of the best possible results. As a rule, the men were given the tests in groups of five hundred or more. Generally, the room used for the test administration was a large drill hall. The men sat on folding chairs and wrote the tests on boards which were placed in their laps. The chairs were placed, as a rule,

elbow to elbow. Any attempts at cheating were discouraged by the talks given to the men prior to their writing the examination. It would have been difficult, however, to restrain the men from glancing at a neighbor's paper. All of these factors have a bearing on the scores made by the men.

In order to determine the amount of error that might have been introduced in this manner, it would have been well to retest the men under controlled conditions at the school in which this study was conducted or at some other suitable place. It was not possible or practicable for this investigator to undertake this re-testing.

TABLE IX

THE INTELLIGENCE OF THE MEN

The General Classification Test Scores

Score	GROUP A		GROUP B		TOTAL	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
99	4	.22	3	.22	7	.22
98	7	.39	11	.81	18	.57
97	21	1.18	29	2.13	50	1.60
96	26	1.47	52	3.82	78	2.49
95	49	2.76	57	4.19	106	3.38
94	52	2.93	27	1.98	79	2.52
93	53	2.99	47	3.46	100	3.19
92	88	4.96	32	2.35	120	3.83
91	60	3.38	30	2.20	90	2.87
90	120	6.84	99	7.28	219	6.99
89	64	3.60	53	3.90	117	3.73
88	102	5.75	108	7.95	210	6.70
87	57	3.21	53	3.90	110	3.51
86	79	4.45	36	2.65	115	3.67
85	71	4.00	21	1.54	92	2.93
84	106	6.00	30	2.20	136	4.34
83	64	3.60	47	3.46	111	3.54
82	91	5.13	60	4.42	151	4.83
81	51	2.87	30	2.20	81	2.58
80	103	5.81	37	2.72	140	4.47
79	36	2.03	76	5.60	112	3.57
78	69	3.88	21	1.54	90	2.88
77	29	1.63	44	3.25	73	2.33
76	60	3.38	47	3.45	107	3.42
75	32	1.80	41	3.01	73	2.33
74	52	2.93	24	1.76	76	2.43
73	32	1.80	9	.66	41	1.31
72	44	2.47	30	2.20	74	2.36
71	15	.85	31	2.28	46	1.47
70	34	1.92	25	1.84	59	1.88
69	10	.56	24	1.76	34	1.08
68	13	.73	18	1.33	31	.99

TABLE IX (Continued)

Score	GROUP A		GROUP B		TOTAL	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
67	14	.79	33	2.43	47	1.51
66	5	.28	4	.29	9	.29
65	13	.73	10	.74	23	.73
64	13	.73	10	.74	23	.73
63	3	.17	11	.81	14	.45
62	12	.68	5	.37	17	.54
61	2	.11	5	.37	7	.22
60	7	.39	5	.37	12	.38
59			6	.44	6	.19
58	2	.11	3	.22	5	.16
57	4	.22	4	.29	8	.26
56	3	.17	1	.07	4	.13
55			1	.07	1	.03
54			6	.44	6	.19
53			2	.15	2	.06
51			1	.07	1	.03
46	1	.05			1	.03
44			1	.07	1	.03
39	1	.05			1	.03
Total	1774	100.00	1360	100.00	3134	100.00
Mean	83.29		82.65		83.01	
S. D.	8.34		9.69		9.04	

OCCUPATIONAL EXPERIENCE

The Occupational Experience Classification Scale used in this study was arranged by the investigator for the express purpose of differentiating various levels of work in terms of their relation to the bookkeeping and clerical procedures found in Navy supply accounting and disbursing.

It was determined, after adequate study of the Qualifications Card and the Personnel Data Sheets, that the occupational histories of the men fell into six levels. The number assigned to each occupational class and the occupational class description are presented in Table X. The descriptions of the occupational experience of the men were taken directly from the job histories. As has been indicated, this information was obtained from the Qualifications Card and the Personnel Data Sheets.

A number of factors were considered, in addition to the information which appeared on the basic records, before a definite assignment was made to a specific experience classification. The factors that were taken into consideration, in order to make the assignment more accurate, were age, education, length of employment, salary, and a strict analysis and review of the duties of the job as narrated by the man himself.

TABLE X
OCCUPATIONAL EXPERIENCE CLASSIFICATION SCALE

Experience Classification Number	*Description of Occupational Experience Assigned to this Classification*
1	Novices: no experience minor experience of relatively no value newsboy experience part time jobs six months or less of office work odd jobs
2	Non-Related Work Experience - Not Related to Office Procedures: butcher, machinist, mechanical work radio actor, claim adjuster, diamond cutter buyer, boilermaker, bartender electrician, acrobat, brakeman die setter, room clerk, baseball player expediter, claim adjuster, aircraft engineer butter maker, baggage man, movie operator bell hop, laborer, shoe salesman waiter, policeman, railroad switchman spinner, knitter, rod man draftsman, printer, truck driver reporter, advertiser, farmer rigger, jeweler, laboratory technician optician, carpenter, window trimmer usher, tailor, barber messenger, pipefitter, blueprint operator cleaner, entertainer, investigator painter, sterilizer, soda jerker riviter, violinist, golf professional shoemaker, ticket clerk, elevator operator smokechaser, photographer, cement inspector salesman, shipfitter, bread salesman sales clerk, tester, pattern maker greenhouse, leather cutter, gas station attendant
3	Related Experience - Related to Office Procedures: stenographer, timekeeper, secretary mail clerk, typist, stock clerk bill clerk, checker, office clerk order clerk, freight routing, bank clerk payroll clerk, shipping clerk, bookkeeping clerk claim agent, inventory clerk, accounting clerk posting clerk, commissary clerk, yard clerk mail clerk, credit clerk, storekeeper file clerk, record clerk, rate clerk

TABLE X (Continued)

Experience Classification Number	*Description of Occupational Experience Assigned to this Classification*	
4	Business Manager, Owner or Mangerial Supervisor:	
	owner of own business	business manager
	store manager	department manager
	supervisor	insurance manager
5	Highly Related Semi-Professional Experience:	
	junior accountant	full charge bookkeeper
	purchasing agent	senior bank teller
	junior cost accountant	paymaster
	chief timekeeper	chief storekeeper
	senior office clerk	senior clerical
6	Professional Occupational Experience:	
	senior accountant	office manager
	senior cost accountant	lawyer
	teacher	comptroller
	county treasurer	office executive
	collector of internal revenue	office manager
		certified public accountant

Table XI gives a summary of the occupational backgrounds of the men in the study in terms of the occupational experience classification number established in Table X.

Because approximately 40 percent of the men in the study were in the seventeen to twenty-year age bracket, inclusive, it is to be expected that approximately 35 percent of the men fell in occupational classification one and two. These young men had not had time to enter into and progress in an occupation.

The fact that there were approximately 32 percent in occupational class three and an approximate total of 32 percent in classes four, five, and six, inclusive, gives assurance that adequate sampling was present for each of the occupational classes.

TABLE XI

OCCUPATIONAL EXPERIENCE CLASSIFICATION

Code Class	GROUP A		GROUP B		TOTAL	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
1	279	15.73	230	16.90	509	16.24
2	313	17.64	257	18.90	570	18.18
3	675	38.05	350	25.75	1025	32.72
4	227	12.80	263	19.34	490	15.64
5	207	11.67	185	13.60	392	12.50
6	73	4.11	75	5.51	148	4.72
Total	1774	100.00	1360	100.00	3134	100.00
Mean	2.99		3.10		3.04	
S. D.	1.34		1.45		1.40	

BUSINESS STUDENTS VERSUS NON-BUSINESS STUDENTS

Earlier in this study a comparison of storekeeping with civilian bookkeeping, record keeping, and clerical procedures was presented. The conculsion was drawn that the course that the men studied in the Naval Training School was a specific type of bookkeeping and record keeping designed for a particular accounting system. It was also pointed out that the Navy recording activities embraced a system that was entirely foreign to practices as commonly found in civilian life. In order to account for any differences that might arise from the fact that certain of the students had studied business subjects during their civilian school days, an attempt was made to differentiate between business students and non-business students.

After various means of differentiating had been tried out, the investigator finally adopted the simple scheme of differentiating students as "Business " or "Non-Business" on the basis of whether or not they had studied bookkeeping or accounting in civilian schools. The school levels considered were high school, business college, college, technical college, university, and correspondence courses, inclusive. No attempt was made to differentiate between courses in bookkeeping and accounting on the various school levels. The criterion that was applied was a minimum of one year's study of bookkeeping or accounting.

In order to expedite the statistical treatment of the data, the business and non-business cases in the study were coded as follows:

Code Number	*Group*
1	Business Students - those having had at least one year of bookkeeping or accounting in school.
2	Non-Business Students - those who had not studied bookkeeping or accounting.

Table XII reveals the number and percentage of the men who were classed as business students and the number and percentage of the men who were classed as non-business students. It will be noticed that in Group A approximately sixty percent of the men had bookkeeping or accounting courses as opposed to only forty-eight percent in Group B. Insofar as the total group is concerned, the men in the study were fairly evenly divided as to previous courses in bookkeeping or accounting.

TABLE XII

BUSINESS STUDENTS vs. NON-BUSINESS STUDENTS

Code Class	GROUP A		GROUP B		TOTAL	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
1	1076	60.65	656	48.23	1732	55.27
2	698	39.35	704	51.79	1402	44.73
Total	1774	100.00	1360	100.00	3134	100.00
Mean	1.61		1.48		1.55	
S. D.	.49		.50		.50	

ARITHMETIC ACHIEVEMENT—GROUP A

The arithmetic achievement of 1774 of the men in the study, comprising Group A, was measured by a "Standard Test in Arithmetic." This examination was composed of twenty questions covering the four fundamental processes in arithmetic, including decimals and simple fractions. An arithmetical reasoning test was substituted for this test during the course of the testing program. The last 1360 cases of the study, comprising Group B, took the latter test, and the results of this test were not available to the investigator. Since the Arithmetic Achievement Test was classified "Restricted" by the Bureau of Naval Personnel, a copy is not included in the appendices.

Arithmetic achievement was selected as one of the factors which might affect the learning involved in this study. There were few, if any, mathematical requirements in the supply portion of the course of study. The last half of the course of study, which was devoted to disbursing, made heavy demands upon the basic arithmetical knowledge and ability of the subject. Possession of or lack of ability in arithmetic would, consequently, be reflected in the grades received in the disbursing tests, with subsequent effect upon the final score, which was used as the criterion in this study.

Table XIII gives the number and percentage of men who scored at various levels on the arithmetic achievement examination. As far as this investigator could determine, there were no standard scores available for the results of this examination.

TABLE XIII

THE ARITHMETIC ACHIEVEMENT OF THE MEN IN GROUP A

Score	*Number*	*Percent*	*Score*	*Number*	*Percent*
99	101	5.69	68	2	.11
97	2	.11	67	6	.34
96	2	.11	66	1	.05
95	223	12.59	65	100	5.65
94	6	.34	64	4	.22
93	1	.05	63	5	.28
92	8	.45	62	2	.11
91	8	.45	61	2	.11
90	229	12.94	60	94	5.31
89	4	.22	59	3	.17
88	5	.28	58	3	.17
87	10	.56	57	7	.39
86	9	.51	56	1	.05
85	212	11.97	55	51	2.87
84	2	.11	54	3	.17
83	6	.34	53	1	.05
82	1	.05	52	2	.11
80	197	11.12	51	1	.05
79	1	.05	50	51	2.87
78	8	.45	49	1	.05
77	4	.22	47	1	.05
76	10	.56	45	27	1.52
75	154	8.69	40	17	.96
74	8	.45	36	1	.05
73	3	.17	35	14	.79
72	12	.67	30	6	.34
71	1	.05	25	9	.51
70	122	6.89	15	3	.17
69	5	.28	10	2	.11
Total				1774	100.00
Mean				77.92	
S. D.				16.02	

RECENCY OF EDUCATIONAL EXPERIENCE—GROUP B

In the initial plans for this study, the recency of educational experience of the men was ignored. The investigator ignored this factor of adult learning on the hypothesis that the age of the subject, in relation to the number of years of formal education he possessed, would indicate the subject's recency of educational experience. This point, however, was consistently raised and challenged by critics whenever a review of the study was made during its formative stages. The investigator, therefore, deemed

it pertinent to the problem to add this area as a possible determiner of the degree of success of adult learning.

The recency of educational experience, for the purposes of this study, is measured by the number of years that the men had been out of school. School attendance, for this purpose, was construed as full time day-school attendance.

As the collection of data for this factor was undertaken after 1774 cases had been recorded, it was necessary to constitute a new group. This new group is referred to as Group B in this study. Group B, then, will be used to measure the effect of recency of educational experience on learning. The information on recency of educational experience was taken

TABLE XIV

RECENCY OF EDUCATIONAL EXPERIENCE OF THE MEN IN GROUP B

Number of Years Out of School	*Number*	*Percent*
0	193	14.20
1	162	11.91
2	42	3.09
3	37	2.72
4	35	2.57
5	52	3.82
6	41	3.01
7	53	3.90
8	49	3.60
9	80	5.88
10	76	5.58
11	67	4.92
12	76	5.58
13	47	3.47
14	50	3.69
15	56	4.12
16	63	4.65
17	55	4.04
18	31	2.28
19	39	2.86
20	25	1.85
21	13	.95
22	11	.81
23	4	.29
24	2	.14
27	1	.07
Total	1360	100.00
Mean		8.43
S. D.		6.51

from the Personnel Data Sheet and checked against the entries on the Qualifications Card.

It follows that a man who had been out of school "O" number of years had, in reality, had no interruption in his formal school-learning situation. The number of years out of school was determined from the line on the Personnel Data Sheet and Qualifications Card labeled, "Date Last Attended School." The number of elapsed years between the date on that line and the year-date that the subject was undergoing the learning situation of this study, constituted the number of years out of school.

Table XIV gives the number and percentage of men who were out of school for various lengths of time. It will be noted that approximately 25 percent of the cases fell into the "O" and "1" year classes. This reflects the fact that approximately 25 percent of the men in Group B were in the seventeen, eighteen, and nineteen-year-old category. An adequate and fairly evenly distributed sampling is to be found for the "2" through "20" years-out-of-school categories. The number of cases after twenty years out of school tapers off rather sharply, as might be expected from the ages of the men in the study.

THE CRITERION OF LEARNING ABILITY

The criterion, or measure of learning ability, employed in this study was the mark attained by the subject on a series of tests covering the period of the learning situation. The objective type of test was used and, whenever possible, practical problems were included in the supply accounting and particularly in the disbursing tests.

In keeping with the organization of the school, there were actually four different types of tests administered weekly. Each test was administered to four classes comprising approximately two hundred students. The tests administered were:

1. Supply Accounting - test for first, second, third, and fourth week of General Storekeeping.
2. Supply Accounting - test for Aviation; Clothing and Small Stores; Provisions; and Ship's Stores.
3. Supply Accounting - final test for all eight weeks' work.
4. Disbursing - first section - test for first, second, third, and fourth week.
5. Disbursing - second section - test for fifth, sixth, seventh, and eighth week.
6. Disbursing - final test for all eight weeks' work.

As the tests were not standardized, no objective measurements of validity or reliability can be presented. The tests were, in the investigator's judgment, accurate, valid, and, to a large extent, reliable measuring instruments which were applied in a uniformly controlled fashion. The facts upon which this judgment is based will be presented in the paragraphs that follow. The manner in which the tests were constructed, validated, ad-

ministered, and graded insured results which should yield scores as accurate as those obtained in most good testing situations.

In keeping with the course of study, and as outlined in the preceding paragraphs, there were two main areas to be tested: (1) supply accounting, and (2) disbursing. The construction of the tests for each week was assigned to the supervisor of that area, who, meeting with the instructors of that area as a committee, designed a pool of equivalent test items. The committee of teachers were charged with the responsibility of analyzing the test items for the purpose of detecting errors, ambiguity, and other common testing faults. The supervisor in charge of the test construction for the area would prepare the test for each week from the pool of test items which he maintained in his files. Mimeograped or multilithed copies of the tests were then kept in "safekeeping" until the hour for the examination arrived. Each instructor was given, shortly before the test hour, the exact number of tests needed for his class.

Since the subject matter range was very narrow and the material to be learned was specific and applicable to a very highly specialized function, the likelihood of the tests not being valid was not very great. Many of the instructors who served on the committee for the construction of the test items had had a great deal of practical experience in the field, both afloat and ashore. Their contribution in keeping the tests specific and practical was considerable.

As the school in which data for this study were compiled did not adopt a system that would afford reliability coefficients for the examinations, no reliability figures were available for use in this investigation.

Because of large classes and crowded conditions, the tests were administered under rigid regulations and with the utmost attention to security. All examinations were carefully proctored by an instructor. Very often instructors were required to proctor classes other than their own. All safeguards and precautions were taken in order to insure, inso far as possible, that only the single element of the knowledge of the student entered into the test results. The situation can be summarized by the statement that the precautions exercised in the administration of the testing program in this learning situation were greater than those which the investigator believes obtain in ordinary school situations.

A random selection of tests that were administered and which represents each area covered by the course of study is included in Appendix D.

As has been mentioned, each draft was composed of two hundred men. The draft was split up into four divisions, comprising approximately fifty men each, and each division constituted a class. It follows that at any time there were four classes learning the subject matter of a particular

phase of the course of study. Each examination each week was taken simultaneously by four classes, a total of approximately two hundred men.

The tests completed by each class were graded by an instructor who taught another class in this same area and whose class had also taken the test. This rotation of instructors for the purpose of grading tests was strictly adhered at at all times throughout the entire time interval during which this study was in progress. The advantages resulting from this procedure are readily apparent. It aided in obviating any unfairness due to favoritism, with its attendant halo rating, and it also worked in the opposite direction to minimize the effect of any adverse feeling which a student might have engendered. One of its main advantages was in precluding the possibility of an instructor's wishing to demonstrate that his class was superior to the other classes by virtue of its having attained a higher average score than the other classes.

Finally, any questions on grading that arose were settled by the supervisor for that instructional and test area. It should also be emphasized that a standard answer sheet and scoring sheet was provided for each test. This was the instructor's key for grading and scoring the tests. The supervisor was responsible for the preparation of the standard answer sheet and scoring key.

The manner in which the final mark, which in this study is used as the criterion score, was computed is presented below. These rules were taken verbatim from the school regulations.

METHOD FOR DETERMINING FINAL GRADE AVERAGE
FOR ENTIRE STOREKEEPING COURSE

There will be one test each week for eight weeks in supply.
There will be one test each week for eight weeks in disbursing.
The average of the sixteen weekly grades in supply and disbursing will constitute a SUB-FINAL mark.

After the complete SUB-FINAL mark has been determined, there is added to it the grade made in the final examinations and a FINAL mark for the supply and disbursing courses is determined. This is done in accordance with the following provisions:

At the end of eight weeks of supply accounting a test is given over all of the supply work. At the end of the sixteenth week a test is given over all of the disbursing work. The average of these two examinations covering the entire sixteen weeks of supply and disbursing will constitute *one-half* of the FINAL mark. In other words, it will be added to the SUB-FINAL mark, and after dividing by two, the FINAL mark will be determined.

The manner in which the marks were recorded is illustrated in Appendix E. The card on which the marks were recorded was called the "Permanent Grade Records" and was printed on the reverse side of the

Personnel Data Sheet. The criterion scores used in this study were recorded directly from this record.

It must be noted at this point that no final mark was entered for those who failed. In order to account for a score for all those who failed, it was decided to arbitrarily assign to all failures a score grade of fifty.

In any school, whether it be high school, college, or university, a certain number of the student body probably employ or or attempt to emply unfair means in order to obtain higher grades. Speaking in a forthright manner, cheating does go on in schools. Where a cross section of the population is involved, it is highly probable that a certain amount of cheating during the administration of the tests will be attempted or will actually be successfuly consumated.

Every possible effort was made at the school in which this study was conducted to minimize the effect of cheating upon the scores made by the subjects on their tests. Many of these safeguards have already been discussed. Careful supervision was employed at all times. Groups were mixed; that is, the classes were split-up for the purposes of test administration. Chairs were carefully placed. Equivalent tests were employed. However, notwithstanding all of these safeguards, it is still probably true that a limited amount of cheating or use of other unfair methods of gaining advantage did occur.

It is the opinion of the writer that cheating or use of other methods of gaining unfair advantage would be a negligible factor in the scores made by the subjects and would have no fundamental bearing on the results of the learning ability of the men in this study as evinced by the test results.

Another source of variation in the criterion score could possibly have arisen from the variation in the tests measuring the learning that took place. As explained earlier, the tests for each class were constructed from a pool of items. As a different group of tests was administered to each draft (comprising four classes totaling approximately two hundred men), there was, basically, a series of four equivalent tests. The tests were never, however, statistically equated as to equivalence. Certain errors of measurement were, no doubt, introduced since the tests employed for each draft were not statistically equated as to their equivalence. An a' priori judgment, based on the inspection of the scores achieved by the various drafts, confirms the assumption that the tests were, for all practical purposes, of an equivalent nature. It is also true that a sufficient number of divisions took each test to average out any differences that might have arisen if only one administration of each test had been employed.

Table XV gives the number and percentage of the men whose final mark fell at each criterion score level. In order to analyze the criterion scores received by the men, Table XVI was constructed. The explanation of Table XVI, then, serves as a description for Table XV.

TABLE XV

THE CRITERION—SCHOOL GRADES ACHIEVED

Grade Score	GROUP A		GROUP B		TOTAL	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
99	2	.11			2	.06
98	3	.17	2	.15	5	.16
97	13	.73	12	.88	25	.80
96	28	1.58	19	1.40	47	1.50
95	32	1.80	28	2.06	60	1.91
94	36	2.03	31	2.28	67	2.13
93	55	3.10	40	2.94	95	3.03
92	74	4.18	38	2.79	112	3.57
91	78	4.40	50	3.68	128	4.08
90	95	5.35	45	3.31	140	4.47
89	97	5.47	56	4.12	153	4.88
88	95	5.35	66	4.85	161	5.14
87	96	5.41	43	3.16	139	4.42
86	106	5.98	60	4.41	166	5.30
85	70	3.96	71	5.22	141	4.50
84	77	4.34	57	4.19	134	4.28
83	73	4.11	63	4.63	136	4.40
82	86	4.85	51	3.75	137	4.37
81	62	3.49	52	3.82	114	3.64
80	72	4.06	47	3.46	119	3.80
79	65	3.67	43	3.16	108	3.45
78	51	2.87	47	3.46	98	3.12
77	40	2 26	40	2.94	80	2.55
76	48	2.70	43	3.16	91	2.90
75	34	1.92	22	1.62	56	1.78
74	25	1.42	30	2.21	55	1.75
73	24	1.35	34	2.50	58	1.85
72	30	1.69	29	2.14	59	1.88
71	22	1.24	27	1.98	49	1.56
70	14	.79	23	1.69	37	1.18
69	15	.84	20	1.47	35	1.11
68	9	.51	21	1.54	30	.96
67	14	.79	14	1.03	28	.89
66	1	.05	7	.51	8	.26
65	5	.28	8	.59	13	.41
64	1	.05	5	.37	6	.19
63			11	.81	11	.35
62			3	.22	3	.10
61			2	.15	2	.06
60			1	.07	1	.03
50	126	7.10	99	7.28	225	7.18
Total	1774	100.00	1360	100.00	3134	100.00
Mean	81.87		80.08		81.09	
S. D.	11.06		11.54		11.29	

TABLE XVI

AN ANALYSIS OF THE CRITERION SCORES BY GROUPED INTERVALS

Grade Score Range	*Number*	*Percent*
95 - 99	139	4.43
90 - 94	542	17.28
85 - 89	760	24.24
80 - 84	640	20.49
75 - 79	433	13.80
70 - 74	258	8.22
65 - 69	114	3.63
60 - 64	23	.73
Failures	225	7.18
Total	3134	100.00
Mean	81.09	
S. D.	11.29	

It will be noted from Table XVI that the distribution of the scores was fairly normal for the population. Based on the mean score of 81.09, 2081 of the cases, or 66 percent, were above this point. It follows that approximately 1053 of the cases, or 34 percent, were below the mean score. The mean of 81.09 had a standard deviation of 11.29 which meant that sixty-eight percent of the cases fell between a score of 92.38 and 69.80.

CHAPTER III

THE PRELIMINARY STUDIES RELATIONSHIP OF SELECTED FACTORS TO LEARNING ABILITY

COMPARISON OF THE CASES REPRESENTED IN THE PRELIMINARY STUDIES WITH GROUP A

In the preceding chapter a detailed description of the data employed in this study was presented. The information covering the eight factors used to measure the learning ability of adults was presented for the total number of cases reported on in this study. These data, it will be remembered, were divided into two groups, A and B. The basis for this division was that the Arithmetic Achievement Test Scores were available for the first 1774 cases and data on the Recency of Educational Experience were available for the last 1360 cases. The first 1774 cases were designated as Group A and the last 1360 cases were designated as Group B. It follows that Group A and Group B together represent a summation of all the cases. It was these latter data which were used to determine certain basic statistical relationships which will be reported on and discussed in the next chapter.

While the information for the total number of cases was being collected, the investigator undertook several preliminary studies in the hope of determining which of the several selected factors that were being considered for study were of significance to the problem. It was felt that a number of factors which might conceivably be included in the study were not pertinent to the problem and would not contribute to the study as a whole. Among the factors that were considered and ultimately rejected were: (1) marital status; (2) church preference; (3) leadership activities in civilian life; (4) previous military experience; (5) previous typewriting experience; (6) number of different jobs held; (7) length of occupational employment; and (8) vision score based on the Snellen Chart.

After a number of preliminary studies were made with varying numbers of men and for the factors detailed in the preceding chapter and for several of those mentioned above, a detailed study of several factors was undertaken which appeared to yield significant results. The factors selected for the preliminary study were:

1. Intelligence as measured by the General Classification Test Score
2. Arithmetic ability as measured by the Arithmetic Achievement Test Score
3. Years of Formal Schooling
4. Occupational Experience
5. Age

The studies on the relationship of intelligence and arithmetic ability with learning ability as measured by the criterion scores were made first. The number of cases in these two studies was, consequently, only 1576. After these studies were completed, the relationship of formal schooling, age, and occupational experience with learning ability was investigated. The preliminary studies covering these three factors contain 1983 cases.

All of the preliminary studies were based on the number of cases that had completed the course at the time the study was undertaken. While the preliminary studies on intelligence and arithmetic ability covered the first 1576 men who completed the course of study found in the learning situation, the 1983 cases in the preliminary studies on the three other factors not only included these but also an additional 407, making 1983 the total number of men who had completed the course of study prescribed by the learning situation.

It will be noted that the men in the preliminary studies are the same men as described in the preceding chapter under the heading of Group A. This statement is made on the basis of the fact that Group A consisted of the first 1774 cases in the study. It is true that the preliminary studies containing the 1576 cases had 198 subjects fewer than the total of Group A; and that the preliminary studies containing the 1983 cases had 209 cases more than the total found in Group A. In a sampling of this size, however, it was felt that the discrepancy in the number of cases mentioned would not destroy the group values for purposes of comparison.

It would, therefore, be assumed that the sampling used for the preliminary studies and the sampling described in the preceding chapter under Group A are approximately the same population. Evidence that this is the case is found in the comparisons of means, standard deviations, and coefficients which follow. Table XVII shows the degree of similarity or variance between the means and standard deviations of the groups used in the preliminary studies and Group A.

TABLE XVII

MEAN AND STANDARD DEVIATION COMPARISON FOR PRELIMINARY STUDIES AND GROUP A

Variables	*Preliminary Group*		*Group A*		*Mean Differences*	*"t" Score*
	Mean	*S. D.*	*Mean*	*S. D.*		
Criterion Scores	83.15	8.45	81.87	11.06	1.28	2.47
GCT Scores	83.11	8.40	83.29	8.34	.18	.65
Schooling	12.28	1.73	12.05	1.61	.23	.43
Age	23.70	6.30	23.60	6.34	.10	.47
Experience	3.09	1.30	2.99	1.34	.10	1.00
Arithmetic Scores	80.28	13.55	77.72	16.02	2.36	4.58

Table XVII shows not only the difference of the means of the various factors studied for the Preliminary Groups and Group A, but it also gives the significance of the difference between the means in terms of Fisher's "t"[1]. The largest significant difference between the means of the two groups appears for the arithmetic achievement variable. This variation, though significant, is based on an actual mean differentiation which is slight.

The next largest significant difference exists between the means of the Criteroin Scores for the Preliminary Groups in comparison with Group A. This divergence, insofar as the means are concerned, is only 1.28. This variation can be explained, in part, by the fact that in the preliminary study the mean for the criterion and the standard deviation of that mean were obtained on the basis of excluding the failures from the score tabulations. The failures in the Group A study were arbitrarily assigned a score grade of 50. Omission of the lower limit scores made by the failures would not only tend to raise the final mean score in the preliminary study but it would also serve to lower the standard deviation significantly as exclusion of the failures would narrow the range.

Considering the fact that the preliminary groups differed in actual number of cases from Group A, the similarity of means and standard deviations of those means and the lack of any significant differences between the means, with the exceptions noted, should be sufficient proof that the findings of the preliminary study are applicable to the total group and can be considered as an integral part of the study.

Another measure of the comparability of the groups used in the preliminary studies and Group A of the final study will be presented in Table XVIII and the discussion which follows it. Since this measure is based upon the coefficients of correlation obtained between the several variables and the criterion, it is believed best to present it following the discussion of the use of the coefficient correlations in the preliminary studies.

In addition to the detailed study of the variables that was undertaken in the preliminary investigations, these same variables were studied in relation to the men who had failed. These detailed failure studies for each of the variables are reported on in this chapter.

As the preliminary studies were undertaken, the investigator attempted to show not only the gross relationship between the factor being studied and learning success but also the relationship between the criterion scores and varying amounts or degrees of the factor. In termining the zero order coefficient of correlation for the factor under study and the

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[1] John F. Kenney, *Mathematics of Statistics*. Part Two. New York: D. Van Nostrand Company, 1939, p. 86.

criterion scores, the Pearson produt-moment method[1] was employed. In using this method, the investigator found that the mean criterion score for each factor group could be calculated from the scattergram which was employed in calculating the correlation. This detailed presentation of the relationship of the various factor score groups to its mean criterion score is presented in the tables and graphs that follow in this chapter.

It would be well to point out here that a different method was employed in treating the data in the preliminary studies from that used in the final studies for the purpose of obtaining the mean, standard deviation, and zero order coefficeints of correlation. In the preliminary studies the factors were hand tabulated in grouped series as follows:

Factor	*How Tabulated*
Criterion Scores	in intervals of five
GCT Scores	in intervals of five
Arithmetic Scores	in intervals of five
Age	in intervals of three

As will be discussed in detail in the following chapter, the data for Group A, Group B, and the Total Group were machine tabulated in discrete series. The mean, standard deviation, and coefficients were obtained by machine methods. These methods will also be explained in the next chapter.

Reference has been to the fact that another method of determining the comparability of the group used in the preliminary study and Group A of the final study was to compare the correlations obtained between the several variables and the criterion. These relationships are shown in Table XVIII.

TABLE XVIII

COMPARISON OF COEFFICIENTS OF CORRELATION OF THE ZERO ORDER FOR PRELIMINARY STUDIES AND GROUP A

Zero Order Correlation between Criterion Scores and	PRELIMINARY GROUP		GROUP A	
	"r"	*"t" Score*	*"r"*	*"t" Score*
Age - - - - - -	.22	9.13	.22	9.26
Formal Schooling - -	.325	14.47	.36	15.16
General Classification Test	.43	19.15	.428	18.11
Occupational Experience	.51	22.71	.49	20.63
Arithmetic Achievement	.40	15.88	.37	15.58

As has been previously stated, the cases in the preliminary studies were hand tabulated and the correlations were determined by the Pearson

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1 Henry E. Garrett, *Statistics in Psychology and Education*. New York: Longmans, Green and Company, 1939, pp. 289-309.

product-moment method. As will be pointed out in more detail in the following chapter, the data for Group A were tabulated in discrete series by the Hollerith punched-card method. The coefficients of correlation were determined by the Dwyer[1] adaptation of the square root method. Considering that the two groups, because of variations in numbers, are not identical, it is reassuring to find that the coefficients of correlation varied as little as they did between the groups. Differences are, of course, apparent, but they are minor. The divergence in the Formal Schooling factor correlation can be explained in part by the fact that there is a larger representation of older men in the preliminary group than in Group A. This can be noted from the variation in age of Group A and Group B as presented in the preceding chapter. The older group possessed more formal schooling, which is reflected in the slight shift of the correlation between formal schooling and learning success as measured by the criterion scores.

Considering the fact that the preliminary groups differed in actual number of cases from Group A, the similarity of the zero order coefficients of correlation obtained as between the various factors and the criterion scores, with the exceptions noted, should be sufficient proof that the findings of the preliminary study are applicable to the total study and can be considered as an integral part of it.

THE RELATIONSHIP OF INTELLIGENCE TO LEARNING ABILITY

The first preliminary study that was undertaken was the determination of the relationship between intelligence as measured by the General Classification Test Scores with learning ability as measured by the Criterion Scores. As has been pointed out, the number of cases involved in this study was 1576. The relationship that was found is expressed in Table XIX.

Figure 13 illustrates the relation of the General Classification Test Scores to those who failed. It serves to emphasize, on the basis of those who failed to succeed, the relationship of intelligence and learning ability as here measured.

It will be noted that a direct and positive relationship does exist between the General Classification Test Scores and the Criterion Scores. The higher the General Classification Test score interval, the higher is the mean Criterion Score for that interval. This relationship can be expressed by the zero order coefficient of correlation for the 1576 cases. This coefficient of correlation was found to be .43, as reported in Table XVIII.

The relationship of the General Classification Test Score Groups in Table XIX to the total population from which they were drawn was pre-

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1 Paul S. Dwyer, "The Square Root Method and Its Use in Correlation and Regression," *The Journal of the American Statistical Association*, Vol. 40, (December, 1945), p. 499.

sented in Tables VI and VIII. The number and percentage of the men who achieved scores at the various Criterion Score levels in the total study were presented in Table XVI.

TABLE XIX

MEAN OF CRITERION SCORES ATTAINED BY GENERAL CLASSIFICATION TEST SCORE GROUPS

GCT Score Group	*Mean of Criterion Scores*	*Number*	*Percent*
95-99	74	15	1.00
90-94	86.5	320	20.00
85-89	84.2	332	21.10
80-84	82.5	374	23.70
75-79	79.8	209	13.40
70-74	77.6	164	10.40
65-69	75	45	2.90
60-64	71.2	32	2.10
55-59	74	15	1.00
Total		1576	100.00
83.11 Mean	82.60		
8.40 S. D.	8.75		

It will be noted that the mean Criterion Score is 82.60. Those men who had a GCT score of 80 or better scored at or above the mean. Those men who possessed a GCT score of 79 or less scored below the mean. The relationship of the GCT score to the mean Criterion Score was direct.

THE RELATIONSHIP OF YEARS OF FORMAL SCHOOLING TO LEARNING ABILITY

After several hundred more students had progressed through the school, additional preliminary studies of the various factors, as explained earlier in this chapter, were undertaken. One of the first of these studies was the determination of the relationship between the years of formal schooling possessed by the subjects with learning ability as measured by the Criterion Scores. As has been pointed out, the number of cases involved in this phase of the preliminary studies was 1983.

The relationship that was found is expressed in Table XX. It will be noted that 51 percent of the cases fell at the mean of a high school education. Those who had more than a high school education and those who had less than a high school education were fairly evenly distributed.

Figure 15 illustrates the relation of the years of formal schooling levels to those who failed. This serves to emphasize, on the basis of those

who failed to succeed, the relationship of the years of formal schooling possessed by the subjects and learning ability as measured in this study.

A marked and direct relationship exists between the amount of formal schooling and success as measured by the criterion score. The greater the number of years of formal schooling, the higher is the mean criterion score for that level. It appears that with each additional increment of one year of formal schooling an increase in the mean criterion score resulted. This positive relationship can be expressed by the zero order coefficient of correlation for the 1983 cases. This coefficient of correlation was found to be .325, as reported in Table XVIII.

TABLE XX

MEAN OF CRITERION SCORES ATTAINED BY YEARS OF FORMAL SCHOOLING

Years of Formal Schooling		*Mean Criterion Scores*	*Number*	*Percent*
7		69.5	8	.4
8		77.7	38	1.9
9		78.5	58	2.9
10		77.0	160	8.1
11		80.0	217	11.0
12		84.0	1011	51.0
13		86.0	220	11.1
14		87.0	138	7.0
15		88.8	46	2.3
16		88.3	62	3.1
17		88.5	18	.9
18		90.0	7	.3
	Total		1983	100.00
12.28	Mean	82.60		
1.73	S. D.	8.75		

It will also be noted from Table XX that those who had 11 years or less of formal schooling scored below the mean score of 83.15. Those who had twelve years of formal schooling scored at the mean and those who had more than twelve years of formal schooling scored above the mean. As has been already pointed out, the relationship between the years of formal schooling and the mean score attained by that formal schooling group was direct and positive.

THE RELATIONSHIP OF AGE TO LEARNING ABILITY

Another one of the early studies that was undertaken was the determination of the relationship of the ages of the men to their learning ability

as measured by the criterion scores. As has been previously pointed out, the number of cases involved in this phase of the preliminary studies was 1983.

It will be noted that the ages were grouped for study in intervals of three. This grouping was not based upon any particular scientific evidence or reason but rather upon an a'priori judgment of age relativity. The one grouping that is open to question as a homogeneous grouping is the age range of seventeen, eighteen, and nineteen. It has been held that there exists a great deal of overlapping from late adolescence to early manhood during these years.

It is true that a great deal of variation probably exists in this age range. Many of the seventeen and eighteen-year-olds would still tend to be in late adolescence, even though they were in Navy uniform. On the other hand, many of the eighteen and nineteen-year-olds would be well into early adulthood. It is apparent that it would be impracticable to differentiate this age level upon a maturity basis. The fact that the seventeen, eighteen, and nineteen-year-old group is not homogeneous is, therefore, recognized and should be taken into consideration in analyzing the statistics for this group.

Figure 17 illustrates the relation of failures to age. This serves to emphasize, on the basis of those who failed to succeed, the relationship of age and learning ability as measured in this study.

TABLE XXI

MEAN OF CRITERION SCORES ATTAINED BY AGE GROUPS

Age Groups		*Mean of Criterion Scores*	*Number*	*Percent*
17-18-19		79	610	30.8
20-21-22		84	625	31.5
23-24-25		86	139	7.0
26-27-28		87	184	9.3
29-30-31		86.5	136	6.9
32-33-34		87	123	6.2
35-36-37		85	81	4.1
38-39-40		84.5	50	2.5
41-42-43		81	26	1.3
44-45-46		80	7	.3
47-48-49		84.5	2	.1
	Total		1983	100.00
23.7	Mean	83.15		
6.3	S. D.	8.45		

It will be noted from Table XXI that between the ages of twenty and forty the mean criterion score for each of the age groups did not vary

appreciably. In contrast, it may be noted that the seventeen-through-nineteen-year age group attained a mean criterion score which was significantly lower than the twenty through forty year age groups. Lower mean criterion scores were also attained by the few cases falling in the forty-one through forty-six year age groups.

It will be noticed that the twenty-three through thirty-four year age groups apparently scored the highest mean criterion scores. The variations between these age groups is slight and probably not statistically significant. The fact that the two cases in the forty-seven through forty-nine year age group scored above the mean is not considered significant as the number of cases in this age group precludes the drawing of any conclusions.

The failure record illustrated in Figure 17 reveals substantially the same relationship for the seventeen-through-nineteen-year age group as did Table XXI and Figure 16. This emphasizes the fact that certain ages contributed more failures than did other age groups.

It may be said, then, that between the ages of twenty and forty no appreciable difference was found in the means of the criterion scores of the various age groups. A zero order coefficient of correlation of .22 was found between Age and the Criterion Scores, as reported in Table XVIII. This tends to bear out the fact that those in the late twenties and thirties tended to do somewhat better than the younger men. The significance of this correlation is treated in detail in the following chapter.

THE RELATIONSHIP OF OCCUPATIONAL EXPERIENCE TO LEARNING ABILITY

The study of the relationship of occupational experience to learning ability as measured by the criterion scores was undertaken after the Occupational Experience Classification Scale presented in Table X had been developed. The use of a numbering code for classifying occupational experience permitted the various occupations to be treated statistically. As has been pointed out, the number of cases involved in this phase of the preliminary studies was 1983.

The relationship that was found is expressed in Table XXII. It will be noted that each experience classification was fairly well represented with the possible exception of class six, which contained only four percent of all the cases reported on.

Table XXII reveals that a direct and marked relationship exists between the Occupational Experience Classification and the criterion score. It will be noted that the mean criterion score for each class is definitely higher as each class code number increases from one through six. It is probably a safe assumption that this increase is not due to the effects of occupational experience alone, but rather reflects the fact that occupational experience as a measure of learning ability incorporates more of the variables

that make for learning success than does any other single factor. In other words, the man who held the most responsible job, either in a professional, semi-professional, or managerial capacity, probably had more of the variables or qualities that make for learning success than did the men who had not achieved. The latter, of course, is an assumption and must be treated as such.

TABLE XXII

MEAN OF CRITERION SCORES ATTAINED BY OCCUPATIONAL EXPERIENCE CLASSIFICATION

Experience Classification		*Mean of Criterion Scores*	*Number*	*Percent*
1		75.6	297	15.0
2		78.6	305	15.4
3		84.0	834	42.0
4		86.0	243	12.3
5		89.7	224	11.3
6		91.0	80	4.0
	Total		1983	100.00
3.09	Mean	83.15		
1.30	S. D.	8.40		

The positive relationship between occupational experience and learning ability can be expressed by the zero order coefficient of correlation for the 1983 cases. This relationship yielded the highest positive correlation of any of the factors analyzed in the preliminary studies. The probable reason for this was presented in the preceding paragraph. The coefficient of correlation between Occupational Experience and the Criterion Scores was found to be .51.

THE RELATIONSHIP OF ARITHMETIC ACHIEVEMENT TO LEARNING ABILITY

At the time the preliminary study for the relationship of intelligence to learning ability was undertaken, another study was begun for the purpose of measuring the relationship of the arithmetic ability of the men, as measured by an Arithmetic Achievement Test, to their learning ability as measured by the Criterion Scores. The same number of cases was employed in this study as was employed in the study of the intelligence factor. This number was 1576. The relationship that was found is expressed in Table XXIII.

Figure 21 illustrates the relation of the Arithmetic Achievement Test Scores to those who failed. It serves to emphasize, on the basis of those who failed to succeed, the relationship of arithmetic ability and learning ability as here measured.

A direct and positive relationship exists between arithmetic ability and learning ability as measured by the criterion scores. It will be noted that as the arithmetic test scores increased, the mean criterion scores increased correspondingly. This positive relationship can be expressed by the zero order coefficient of correlation for the 1576 cases. This coefficient of correlation was found to be .42, as reported in Table XVIII.

TABLE XXIII

MEAN OF CRITERION SCORES ATTAINED BY ARITHMETIC TEST SCORE GROUPS

Arithmetic Test Score Group		*Mean of Criterion Scores*	*Number*	*Percent*
95-99		86	298	19.0
90-94		83	220	14.0
85-89		82	206	13.1
80-84		82	176	11.1
75-79		79	154	9.8
70-74		76	124	7.8
65-69		78	107	6.8
60-64		75	95	6.0
50-59		74	198	12.4
	Total		1576	100.0
80.28	Mean	80.43		
13.55	S. D.	9.45		

Table XXIII shows that the mean Criterion Score is 80.43. Those men who had an Arithmetic Test Score of 80 or better scored at or above the mean. Those men who had an Arithmetic Test Score of 79 or less scored below the mean. The relationship of the Arithmetic Achievement Test Scores to the Criterion Scores was direct. A review of the General Classification Test Scores in relation to the Criterion Scores will show a striking similarity to the evidence presented in Table XXIII.

SUMMARY OF THE RESULTS OF THE PRELIMINARY STUDIES

Each of the factors analyzed in the preliminary studies was treated individually in relation to the criterion score. It is obvious that the relationship of other factors such as age, years of formal schooling, occupational experience, intelligence, and recency of educational experience may strongly influence any of the zero order coefficients of correlation that were obtained.

Since the preliminary studies were conducted as a detailed study of the relationship between single variables and the criterion scores and

failure records, the conclusions that may be drawn from these preliminary studies will, of necessity, be presented for each individual factor. The findings for the total study reported in the following chapter and the summary in the concluding chapter adequately present the statistical results based on coefficients of partial and multiple correlation. There is no inference that the conclusions reached from the preliminary studies supersede those presented for the entire study in the following chapter, but rather, they are presented in order to round out the detail and to add to the total information that may be drawn from the study.

The intelligence of the subjects, as measured by the General Classification Test, is a positive predictive factor as to the success of the subject in the learning situation of this study.

1. Those subjects who had a GCT score of 85 or better made the best records in terms of the lowest percentage of below-average criterion scores and the highest percentage of above-average criterion scores. This group had the lowest percentage of failures.
2. Those subjects who had a General Classification Test score of from 70 to 85 were next best.
3. Those who had a General Classification Test score of 70 or less had the highest percentage of below-average criterion scores and the lowest percentage of above-average criterion scores. This group also had the highest percentage of failures.

The number of years of formal schooling possessed by the subject is a positive predictive factor as to the success of the subject in the learning situation of this study.

1. The men who had 13 or more years of formal schooling made the best records in terms of the lowest percentage of failures and below-average criterion scores and the highest percentage of above-average criterion scores.
2. The men who had 12 years of formal schooling were next best.
3. The men who had 11 years or less of formal schooling had the highest percentage of failures and below-average criterion scores and the lowest percentage of above-average criterion scores.

The age of the subject, within certain limits, serves as a positive predictive factor as to the success of the subject in the learning situation of this study.

1. The 17-18-19-year age group contributed the greatest number of failures and had the highest percentage in the below-average group. This group had the smallest percentage in the above-average criterion score classification.
2. The men in the 20-through-40 age range were fairly uniform in their success in the learning situation. However, the age range of 26-through-34 contained the greatest percentage of the men who attained the highest criterion score
3. The men who were in the above-40 age group were not as successful as the men in the 20-to-40 age group. There were, however, two cases which were exceptions. It may be that the number of cases in the above-40 age level was not sufficient to provide an adequate sampling on which to base any conclusions.

The occupational experience of the men, as measured by the Occupational Experience Classification Scale adopted for this study, gave the

most positive single predictive measure of success in the learning situation of this study. As was pointed out earlier, it is probably a safe assumption that this high correlation is not due to the effects of occupational experience alone, but rather reflects the fact that occupational experience, as a measure of learning ability, incorporates more of the variables upon which learning success is dependent than does any other single factor.

1. The men who were in experience classification 5 and 6 made the best records in terms of the lowest percentage of failures and below-average criterion scores. and the highest percentage of above-average criterion scores.
2. The men who were in experience classification 3 and 4 were next best.
3. The men who were in experience classification 1 and 2 had the highest percentage of failures and below-average criterion scores and the lowest percentage of above-average criterion scores.

The arithmetic ability of the men, as measured by the Arithmetic Achievement Test, is a positive predictive factor as to the success of the subject in the learning situation of this study. Its relationship to learning success most nearly approximates the relationship of intellignece to learning success.

1. The men who had an arithmetic test score of 85 or better made the best records in terms of the lowest percentage of failures and below-average criterion scores and the highest percentage of above-average criterion scores.
2. The men who had an arithmetic test score of 70 to 84 were next best.
3. The men who had an arithmetic test score of 70 or less had the highest percentage of failures and below-average criterion scores and the lowest percentage of above-average criterion scores.

CHAPTER IV
THE FINAL STUDY
RELATIONSHIPS OF THE VARIABLES TO LEARNING ABILITY

In the preceding chapter the relationship of five variables to learning ability as measured by the criterion score was presented. The relationships were shown in terms of the zero order coefficients of correlation, the mean criterion scores attained by varying groups in each factor, and finally by a study of failures in relation to the varying groups within each factor.

Certain other relationships were desired, however, such as measures of the reliability of the differences between the groups, the partial and multiple correlations of the various factors, and certain intercorrelations. To obtain these measures most expeditiously, with least likelihood of error, machine techniques were employed.

The data were, therefore, prepared for Hollerith machine tabulation. Appendix F illustrates the manner in which the data were tabulated so as to be readily punched on IBM cards. A sample punched card (Appendix G) shows the manner in which the cards were prepared. The determination of the mean, standard deviation, zero order, partial, and multiple coefficients of correlation was accomplished by machine techniques employing both the Hollerith tabulators and the fully automatic calculating machine. The methods employed are adequately treated by Dwyer[1], and the formulae used are listed in Appendix H.

It would be well to note that in employing the machine techniques it was necessary to assign a system of notation to the eight variables measured. As these notations are employed in several of the tables in this chapter, they are listed below.

Notation	*Variable*
X_1	Criterion Score
X_2	General Classification Test Scores
X_3	Years of Formal Schooling
X_4	Age of the Men
X_5	Occupational Experience Classification
X_6	Business Students vs Non-Business Students
X_7	Arithmetic Achievement Test Scores
X_8	Recency of Educational Experience

THE RELATIONSHIP OF GROUP A TO GROUP B

As has already been pointed out, the men of the study were finally divided into two groups: Group A, totaling 1774 subjects, included data on the arithmetic achievement of the subjects; Group B, totaling 1360 subjects, included data on the recency of educational experience of the

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1 Paul S. Dwyer, "Recent Development in Correlation Technique," *The Journal of the American Statistical Association*, Vol. 37, (December, 1942), pp. 441-460.

subjects. In order to determine the comparability of the two groups, the significance of the difference between the means of the two groups for each factor was determined by Fisher's "t"[1]. The results obtained for each factor are shown in Table XVII.

TABLE XXIVA

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF GROUP A AND GROUP B

Code	*Factor*	*Group A*		*Group B*		*Difference of*	*"t"*
		Mean	*S. D.*	*Mean*	*S. D.*	*Means*	*Score*
X_1	Criterion Scores	81.87	11.06	80.08	11.54	1.79	4.45
X_2	GCT Scores	83.29	8.34	82.65	9.69	.64	1.92
X_3	Years of Schooling	12.05	1.61	12.17	1.84	.14	2.33
X_4	Age of Men	23.60	6.34	26.88	6.45	3.29	14.30
X_5	Experience Class	2.99	1.34	3.10	1.45	.11	2.20
X_6	Business Students	1.61	.49	1.48	.50	.13	3.20

The significance of the difference between the means of two groups, in a sampling of this size, does not vary much from the true mean of the sampling of the universe in accordance with the Fisher "t", if the obtained "t" falls between 1.96 and 2.58. It will be noticed from the results, as presented in Table XXIVA, that the significance of the difference for variables X_1, X_4, and X_6 was beyond the limits of chance at the one percent level, and this indicated that for some reason or other the two groups were not homogeneous with respect to these characteristics.

It will be noted that the groups are not significantly different in respect to factors X_2, X_3, X_5. The largest significant difference appears for the factor of age. This can be explained by the fact that Groups A and B differed horizontally from a time viewpoint in that Group A represented thefirst 1774 cases who reported at the school and Group B represented the last 1360 cases. As the war progressed, older men were called into service. This is reflected in the difference of the means of the two groups.

The only explanation that can be offered for the significant but slight variation in factor X_1—the Criterion Score—is based on the fact that the older men comprising Group B tended to score slightly higher than the younger men comprising Group A. The men in Group B had more schooling, and what is more to the point, a broader background of pertinent occupational experience. The effect of these varibles on the criterion

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1 John F. Kenney, *Mathematics of Statistics*. Part Two. New York: D. Van Nostrand Co., Inc., 1939. p. 140. See formula 7, Appendix H.

score is shown in the zero order, partial, and multiple correlation tables presented later in this chapter.

The fact that fewer men in Group B had completed courses of study in the field of business subjects was of interest to the investigator. It is a well recognized fact that business courses, or as they are commonly termed, commercial courses, were introduced on a widespread scale into the high school during the past decade or two. The majority of the younger men had had courses in business because they had had more opportunity to elect these courses than had the older men in Group B. When the older men attended high school, the probability is that more emphasis was placed upon the classical rather than upon the practical courses. Table XII shows that 60 percent of the men in Group A had studied business subjects, as opposed to only 48 percent in Group B.

INTERRELATIONSHIPS OF FACTORS MEASURED AS DETERMINED BY ZERO ORDER CORRELATIONS

While the intercorrelations of the variables measured do not distinguish their relative influence on the criterion score until the effect of the other variables has been partialed out, nevertheless they serve a purpose in that they do show tendencies and gross relationships.

As was reported in the preceding chapter, several of these measures were previously obtained in the preliminary studies, particularly those which it was believed would be significant for the purposes of the present investigation. However, for the sake of comparison and as a basis for further computational work, the complete set of relationships for both groups nad the total were machine calculated and are presented in Tables XXIV and XXV.

It will be recalled that data on arithmetic achievement were available for Group A and not for Group B, and that data on recency of educational experience were available for Group B and not for Group A. This accounts for the gaps under these headings in the two tables which follow.

As has been stated, the coefficients of correlaton between the variables are shown in Tables XXIV and XXV. These two tables give the same information in different form. The significance of each of the coefficients of correlation was computed, using a formula presented by Kenney[1], and is shown in the tables under the "t" column. It should be pointed out, however, that when there is a sample of this size, the coefficient of correlation of the sample does not differ very much from the true coefficient of correlation for the universe.

The coefficients that are italicized in Tables XXIV and XXV are those that are less than 2.58 "t" score, which places them at the 1% level. These are considered to be not significant coefficients. The fact that the

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1 Kenney, *op. cit.*, p. 156. Formula 8, Appendix H.

majority of the correlations are above the significant level is not, in and of itself, indicative of the fact that there exist strong degrees of relationships among the variables affecting the learning ability of the men in this study.

Group X_1 Correlations—The Variables Correlated with the Criterion. It will be noted that the correlation between intelligence, as measured by the GCT, and the criterion was high and positive. However, the highest correlation with the criterion was obtained with occupational experience. Formal schooling, arithmetic achievement, and age all correlated fairly high and, with the exception of age, with correspondingly large "t" scores denoting significance. It is interesting to note that a fairly large negative correlation was obtained between the criterion scores and those who had had business courses. This would tend to bear out the contention that the types of previous courses in business that the subjects may have had did not affect their approach to the learning situation in this problem. It might well be that a knowledge of civilian practices hindered rather than aided the learners in adjusting to a new system of record keeping and bookkeeping, although this is problematical. It is also interesting to note that a very slight negative correlation, having no "t" score significance, was obtained between the criterion and the recency of educational experience. The amount of time out of school evidently had little effect upon the learning ability of the men in the study.

Group X_2 Correlations— The Variables Correlated with the General Classification Test Scores. In the second group, the variable that gave the highest correlation with the GCT Scores was the Arithmetic Test Scores. This is not at all surprising, since it is recognized that most intelligence tests measure the same type of abstract reasoning that is necessary to score well in arithmetic tests. An examination of the General Classification Test revealed that a number of the items called for the same abilities as needed in the Arithmetic Achievement Test. Formal schooling and occupational experience both correlated fairly high with the General Classification Test Scores. This merely emphasizes the fact that those who are natively better endowed tend to go to school longer and to hold better jobs.

Group X_3 Correlations— The Variables Correlated with Years of Formal Schooling. The two correlations in the Years of Formal Schooling section that are of interest are the positive relation to occupational experience and the negative relation to business courses. It would appear that the longer one attended school, the better job he held in terms of the job classification employed in this study. The second point is fairly obvious —if one attended school for a fairly long period of time, it would not insure that he would take business courses.

Group X_4, X_5, and X_6 Correlations—The remaining Variables Correlated with Age, Occupational Experience, and Business Courses.

In the fourth section, the high correlation obtained between Age and Occupational Experience is to be expected since those men who were older had had the opportunity to get established in their fields of work. It is also interesting to note that Age had no correlation with Arithmetic Achievment. This is a positive indication that Age has less bearing on the learning ability of men than have other factors.

The most important correlation, and the highest one obtained between any of the factors in the study, was that obtained between Age and Recency of Educational Experience for Group B. This high correlation bore out the eary a'priori assumption of the investigator to the effect that recency of educational experience would be reflected by the ages of the men in the study. Because this corrlation btwen the age factor and recency of educational experience is ho high and positive, the investigator did not deem it necessary to include it as a variable in the partial correlations. It was felt that the age factor alone would serve sufficiently to identify recency of educational experience, and in partialing out age the same results would be attained as in partialing out recency of educational experience.

The very small negative correlation, which approached zero, that was obtained between the General Classification Test and Recency of Educational Experience may have more significance than many of the larger positive correlations found in Tables XXIV and XXV. It emphasizes the fact that the number of years the subject was out of school did not affect his criterion score. In other words, the men who had been out of school for a number of years did quite as well as those who had attended school recently. This is borne out by the age-to-criterion correlations. The fact that there was no high correlation between the age of the men and the criterion scores points out the fact that as the men became older they did not score proportionately lower in the General Classification Tests nor in the Criterion Tests.

TABLE XXIV

ZERO ORDER COEFFICIENTS OF CORRELATION BETWEEN THE VARIABLES MEASURED

Variable	*GROUP A*		*GROUP B*		*TOTAL*	
	r	*t*	*r*	*t*	*r*	*t*
X_1-Criterion to						
GCT	.428	18.11	.472	17.33	.45	25.19
Schooling	.36	15.16	.32	11.80	.34	19.03
Age	.22	9.26	.16	5.90	.17	9.52
Experience	.49	20.63	.36	13.27	.44	24.64
Courses	−.26	10.95	−.10	3.68	−.21	11.75
Arithmetic	.37	15.58				
Recency			*−.07*	*2.58*		
X_2-GCT Scores to						
Schooling	.31	13.05	.357	13.28	.33	18.47
Age	.14	5.90	*.082*	*2.95*	.10	5.60
Experience	.30	12.64	.263	9.59	.29	16.23
Course s	−.18	7.58	*−.073*	*2.58*	.13	7.28
Arithmetic	.46	19.38				
Recency			*−.002*	*.37*		
X_3-Schooling to						
Age	.12	5.05	*.03*	*1.10*	.09	5.04
Experience	.32	13.48	.28	10.32	.31	17.35
Courses	−.28	11.79	−.18	6.64	−.23	12.87
Arithmetic	.34	14.32				
Recency			−.26	9.59		
X_4-Age to						
Experience	.49	20.64	.56	20.65	.53	29.67
Courses	*−.001*	*.42*	.13	4.79	.03	1.68
Arithmetic	*.04*	*1.68*				
Recency			.92	33.92		
X_5-Experience to						
Courses	−.25	10.53	*−.044*	*1.48*	.17	9.52
Arithmetic	.23	9.68				
Recency			.43	15.86		
X_6-Courses to						
Arithmetic	.23	9.68				
Recency			.17	6.27		

r = coefficient of correlation

t = significance of the correlation in terms of Formula 8, Appendix H

TABLE XXV

ZERO ORDER CORRELATION TABLE ARRANGED FOR THE VARIABLES MEASURED

	X_1 Criterion	X_2 GCT		X_3 Formal Schooling		X_4 Age		X_5 Experience		X_6 Business Courses		X_7 Arith. Scores		X_8 Educational Recency	
		r	*t*	*r*	*t*	*r*	*t*	*r*	*t*	*r*	*t*	*r*	*t*	*r*	*t*
Group A		.428	18.11	.36	15.16	.22	9.26	.49	20.63	.26	10.95	.37	15.38		
Group B		.472	17.33	.32	11.80	.16	5.90	.36	13.27	.10	3.68			*.07*	*2.58*
Total		.450	25.19	.34	19.03	.17	9.52	.44	24.64	.21	11.75				
Group A				.31	13.05	.14	5.90	.30	12.64	.18	7.58	.46	19.38		
Group B				.36	13.28	*.08*	*2.95*	.26	9.59	*.07*	*2.58*			*.002*	*.37*
Total				.33	18.47	.10	5.60	.29	16.23	.13	7.28				
Group A						.12	5.05	.32	13.48	.28	11.79	.34	14.32		
Group B						*.03*	*1.10*	.28	10.32	.18	6.60			−.26	9.59
Total						.09	5.04	.31	17.35	.23	12.87				
Group A								.49	20.64	*.001*	*.42*	*.04*	*1.68*		
Group B								.56	20.65	.13	4.79			.92	33.92
Total								.53	29.67	*.03*	*1.68*				
Group A										−.25	10.53	−.23	9.68		
Group B										−*.04*	*1.48*			.43	15.86
Total										.17	9.52				
Group A												.23	9.68		
Group B														.17	6.27

INTERRELATIONSHIPS OF FACTORS MEASURED AS DETERMINED BY PARTIAL CORRELATIONS

The pure effect of any one of the factors upon success in learning as measured by the criterion score can be determined by partialing out the the effect of the other factors which were selected for study in this investigation. The square-root method, as adapted by Dwyer[1], was used in obtaining the partial coefficients of correlation.

These partial coefficients of correlation obtained for both Group A and Group B, when the various factors were held constant, are presented in Tables XXVI and XXVII. These tables represent a summary of the work sheets for each of the factors which were studied in relation to the other factors. A sample worksheet is included in Appendix H.

One of the advantages of the Dwyer method for obtaining partial correlations is readily apparent when Table XXVI is examined. It will be noticed that as between the criterion and any selected variable, the effect of partialing out any one factor can be easily read from the table. Line X_2, for example, shows the zero order correlation for GCT to the Criterion Scores, which is .428 for Group A. When formal schooling is partialed out of this correlation we get .316. If Formal Schooling and Age are partialed out of our zero order correlation we get a partial correlation of .298. If, now, we partial out Experience in addition to the two previous factors, our net correlation between GCT and the Criterion Score becomes .232. This, then, is the net correlation after the effects of the other three variables have been partialed out.

The Relationship of Intelligence to Learning Success when the Effects of Formal Schooling, Age, and Occupational Experience are partialed Out. As outlined in the preceding paragraph, line X_2 in Table XXVI shows the zero order correlation between the GCT Scores and the Criterion Scores to be .428 for Group A. As the variables of Formal Schooling, Age, and Occupational Experience are partialed out, the correlation becomes smaller, until we get a net corrlation of .232. It will be noted that the two measures that affect the zero order coefficient correlation between the GCT score and the Criterion the most are Formal Schooling and Occupational Experience. Formal Schooling apparently contributes more to the positive correlation between the two factors under discussion than does Experience in this instance. Age has relatively very little effect on the relationship between the criterion and intelligence as expressed by the partial correlation. This is important as it emphasizes the fact that age is less of a determiner of success than is intelligence or ex-

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1 Paul S. Dwyer, "The Square Root Method and Its Use in Correlation and Regression," *The Journal of the American Statistical Association*, XL, (December, 1945), pp. 493-503. See Formula 4, Appendix H.

perience. When age was partialed out, the coefficient dropped .018 in the case of Group A, and .011 in the case of Group B.

The same information is presented for Group A in Table XXVII, except that the Arithmetic Achievement Test Scores are also included. When this variable is partialed out, in addition to the variables treated in the preceding paragraph, the net coefficient between GCT Score and the Criterion drops to .158. In other words, when this last variable is partialed out, there is a drop of .08. The largest drop in this row was .11, which occurrred when formal schooling was partialed out.

The factor of intelligence, in terms of the General Clasification Test Scores, as a measure of success in learning, according to Table XXVI, is affected by various other factors. Intelligence alone, as evidenced by the GCT Scores, therefore cannot be considered, in and of itself, as a highly positive predictive measure for success in learning under the conditions of this study. In fact, its pure relationship after schooling, experience, and age are partialed out is about one-half of its zero order relationship to the criterion. It is much less than this when the Arithmetic Achievement Score relationship is partialed out.

The Relationship of Formal Schooling to Learning Success when the Effects of Intelligence, Age, and Occupational Experience are partialed Out. Line X_3 in Table XXVI shows the zero order coefficients of correlation for Group A and Group B for Years of Formal Schooling to learning success as measured by the Criterion Scores. It will be noted that as intelligence (GCT) is partialed out the correlation drops rather sharply. The loss in this case is .14 for Group A, and .17 for Group B. As age is partialed out, there is a little drop for Group A and no drop occuring for Group B. This again emphasizes that age was less of a determiner of success in learning, insofar as the conditions of the study are concerned, than was years of formal schooling possessed by the subjects. When occupational experience was partialed out, a very sharp reduction in the net coefficient of correlation occurred. This tends to reveal that the variable of formal schooling, as a factor in learning success, contains large elements of the intelligence and experience factors. Its pure relationship is less than one-half of its zero order relationship to the criterion score.

The same information is presented for Group A in Table XXVII, with the addition of the Arithmetic Achievement Test Scores. When this variable is partialed out, in addition to the variables treated in the preceding paragraph, the net coefficient between Formal Schooling and the Criterion drops to .107. It will be noted that the net correlation, after the Arithmetic Achievement Scores are partialed out, gives a correlation which is very low in comparison with the zero order correlation of the criterion to formal schooling.

The Relationship of Age to Learning Success when the Effects of

Intelligence, Formal Schooling, and Occupational Experience are Partialed Out. Line X_4 in Table XXVI shows the zero order coefficients of correlation for Group A and Group B for Age to learning success as measured by the Criterion Scores. It will be noted that the correlation for Age to the Criterion for Group A, .22, is somewhat higher than for Group B, .16. This is, undoubtedly, due to the fact that Group A constituted a much younger group, 50% of which fell into the seventeen through twenty age levels. The remainder of the group did not present as good a sampling for the older men as was found in Group B.

It is particularly important to note that as intelligence, formal schooling, and occupational experience are partialed out, the lowest coefficient of partial correlation of any of the variables is obtained. The net coefficient of partial correlation between age and the criterion for learning success, when the other factors are partialed out, hovers around zero, $-.012$ in the case of Group A and $-.002$ in the case of Group B.

This negative correlation emphasizes rather sharply that age, in and of itself, did not have a strong bearing on the success or failure of the men in this study, as judged by the criterion. Those men who were older did as well as those who were younger. It would be well to review this partial correlation in the light of the findings obtained from the detailed study of this variable in the preceding chapter. It will be remembered that the men who were in the twenty-through-forty age range achieved mean scores that were highly comparable. It was the younger men in the seventeen-through-nineteen age range that scored significantly lower than the other age levels.

The same information is presented for Group A in Table XXVII, with the addition of the Arithmetic Achievement Test Scores. When this variable is partialed out, in addition to the variables treated in the preceding paragraph, the net coefficient between Age and the Criterion is lowered to .002. This is the same net correlation as obtained with Group B without partialing out the arthmetic scores. The result is very similar to that treated in the preceding paragraph.

The Relationship of Occupational Experience to Learning Success when the Effects of Intelligence, Formal Schooling, and Age are Partialed Out. Line X_5 in Table XXVI shows the zero order coefficients of correlation for Group A and Group B for Occupational Experience as measured by the Experience Classification Scale to learning success as measured by the Criterion Scores. The Group A zero order coefficient of this variable to learning success was .49, which was the highest zero order coefficient obtained in this portion of the study.

In keeping with what has been observed for the other variables, as intelligence, formal schooling, and age are partialed out the coefficient of

correlation becomes smaller. However, it is interesting to note that the largest net coefficient of correlation was obtained as between experience and learning success as measured by the criterion. In other words, occupational experience, as a single variable, gave the best measure of learning success as determined in this study. This holds true even though we partial out the arithmetic achievement test scores, as shown in Table XXVII.

It is true that the variable of Occupational Experience is affected by the other variable. Occupational Experience alone, however, proved to have the highest net coefficienct of correlation with the criterion. This is not at all unexpected as an indication of this was apparent in the Preliminary Study. There it was held that in all likelihood the highly positive relationship between occupational experience and learning success more or less reflected the fact that occupational experience as a measure learning ability incorporates more of the variables that make for learning success than does any other single factor. It was held that in all probability the man who had had the most responsible job, either in a professional, semi-professional, or managerial capacity, had more of the variables or qualities that make for learning success than did the men who had not achieved. It was pointed out that these remarks are an assumption and must be treated as such in the absence of any scientific evidence.

TABLE XXVI

PARTIAL COEFFICIENTS OF CORRELATION FOR THE VARIABLES MEASURED

Correlation of Criterion $-X_1$ *with variable*	*Group*	*Zero Order r*	*Variables Partialed Out*				
			GCT	*School*	*Age*	*Experience*	*Net*
X_2-GCT	A	.428		.316	.298	.232	.232
	B	.472		.356	.345	.308	.308
X_3-Schooling	A	.360	.227		.215	.137	.137
	B	.325	.156		.156	.107	.107
X_4-Age	A	.220	.160	.141		−.012	−.012
	B	.160	.121	.120		−.002	−.002
X_5-Experience	A	.490	.362	.304	.242		.242
	B	.360	.236	.203	.136		.136

TABLE XXVII

PARTIAL COEFFICIENTS OF CORRELATION FOR THE VARIABLES MEASURED

Group A - Including Arithmetic Test Scores

Correlation of Criterion - X_1 with variable	*Group*	*Zero Order r*	*VARIABLES PARTIALED OUT*					
			GCT	*School*	*Age*	*Experience*	*Arithmetic Scores*	*Net*
X_2-GCT	A	.428		.316	.298	.232	.158	.158
X_3-Schooling	A	.360	.227		.215	.137	.107	.107
X_4-Age	A	.220	.160	.141		.012	.002	.002
X_5-Experience	A	.490	.362	.304	.242		.238	.238
X_6-Arithmetic	A	.370	.173	.124	.129	.120		.120

While the results do not bear directly on the problem, it was deemed of interest to determine whether any combination of the variables studied would predict learning success in a more significant manner than any other combination. Coefficients of multiple correlation in relation to learnin success were, therefore, calculated from the data.

The coefficients of multiple correlation presented in Table XXVIII, with their standard error of estimate, were calculated from the regression equations obtained in the partial correlation work sheets as illustrated in Appendix H. The formula employed to obtain these multiple correlations in presented by Dwyer[1].

The coefficients of multiple correlation expressed in Table XXVIII represent the relationship between the scores actually made on the criterion tests indicating success in this learning situation and the criterion scores which could be predicted from a regression equation made up of various teams or batteries of the variables studied.

An inspection of Table XXVIII reveals, however, that none of the combinations of variables appear to be any more accurate in predicting learning success than any other combination. It will be noted that when the Arithmetic Test Score factor is added, for Group A, to the combination of variables, the predictive value of the combination is slightly increased.

TABLE XXVIII

MULTIPLE COEFFICIENTS OF CORRELATION

Combination of Variables to Criterion	*Group*	*R*	*Standard Error of Estimate*
$X_1.X_3X_4X_5$	A	.535	9.32
$X_1.X_3X_4X_5X_7$	A	.576	9.01
$X_1.X_3X_4X_5$	B	.530	9.78
$X_1.X_2X_4X_5$	A	.572	9.04
$X_1.X_2X_4X_5X_7$	A	.600	8.82
$X_1.X_2X_4X_5$	B	.532	9.69
$X_1.X_2X_3X_5$	A	.590	9.61
$X_1.X_2X_3X_5X_7$	A	.603	8.85
$X_1.X_2X_3X_5$	B	.545	9.59
$X_1.X_2X_3X_4$	A	.510	9.51
$X_1.X_2X_3X_4X_7$	A	.529	9.36
$X_1.X_2X_3X_4$	B	.516	9.83
$X_1.X_2X_3X_4X_5$	A	.590	8.90

KEY

X_1 - Criterion Score
X_2 - General Classification Test Scores
X_3 - Years of Formal Schooling
X_4 - Age
X_5 - Occupational Experience
X_7 - Arithmetic Achievement Test Scores
R - Multiple Coefficient of Correlation

1 Dwyer, *op. cit.*, p. 497. Formula 5, Appendix H.

CHAPTER V

THE RESULTS OF THE STUDY

In two introductory chapters (not included in this publication), the need was shown for investigations in the learning ability of adults on the normal out-of-school age levels. This was done in terms of the needs of our various population groups who compose the dynamic social, economic, and cultural aspects of our American scene.

The views of psychologists who have worked with the problem were presented in order to define its place in the psychology of learning. The factors which, in the opinion of psychologists, may affect the learning of adults were presented in order to give an overview to the problem as a whole. Experimental studies were analyzed in order to determine the scope of the contributions that have already been made to this area of psychological investigation.

The remaining chapters (all of which are included in this publication) were devoted to a report on the investigations conducted in this study which undertook to determine by statistical methods the relationship of certain measurable factors upon success in learning, with particular reference to bookkeeping and clerical procedures.

The variables which were investigated were:

1. Age
2. Years of Formal Education
3. Intelligence
4. Occupational Experience
5. Arithmetic Achievement
6. Recency of Educational Experience
7. Previous Courses in Bookkeeping or Accounting

The learning situation was unique in that the environment was highly controlled and all participants were subjected to the same external controls and external motivating forces. These motivating forces can be said to have been stronger than those normally obtained in school-learning situations. Insofar as the limits of this investigation are concerned, these motivating forces were equally applied to all subjects.

The criterion for learning success was a battery of tests administered over equally spaced intervals during the sixteen weeks of the learning situation. As far as can be determined, none of the subjects in the study possessed any advantage by reason of previous training, experience, or knowledge in the particular area covered by the learning situation, other than that which was accounted for by the variables that were studied.

Data were collected on 3134 subjects over a period of two years. The preliminary studies which were undertaken were done by hand tabulation. The data on the final studies were tabulated on IBM (Hollerith) machine

tabulating equipment. The resultant figures were analyzed through the application of computing machine techniques for determining zero order, partial, and multiple coefficients of correlation.

It was hoped that the problem would indicate possible answers to the relationship of the factors and success in learning. Specifically, it was hoped that the study might throw some light on the following relationships:

1. The relation between age and success in learning
2. The relation between years of formal schooling and success in learning
3. The relation between intelligence and success in learning
4. The relation between recency of educational experience and success in learning.
5. The relation between arithmetic achievement and success in learning
6. The relation between occupational experience and success in learning
7. The relation between previous courses in bookkeeping or accounting and success in learning

It may be pointed out that certain relationships were discovered in a series of preliminary studies which included all the variables with the exception of Recency of Educational Experience and Business Students versus Non-Business Students. The results were similar to the more inclusive results obtained with the aid of tabulating and calculating machine equipment.

The relationship between success in learning, as measured in this problem, and the variables selected for investigation was studied for groups of varying size. The preliminary studies with intelligence and arithmetic achievement contained 1576 cases. The preliminary studies with age, formal schooling, and occupational experience contained 1983 cases. The total number of cases included in this study numbered 3134. This total group was divided into Group A, numbering 1774 cases, and Group B, numbering 1360 cases. Conclusions from these studies, based on the zero order coefficients of correlation, may be summarized as follows:

1. Positive relationships were found between the criterion for learning success and the variables investigated in the studies of the different-sized groups. The extent of these relationships is as follows:

ZERO ORDER COEFFICIENTS OF CORRELATION

Variable	*Prelim. Study*	*Group A*	*Group B*	*Total Group*
Intelligence as measured by General Classification Tests	.43	.428	.472	.450
Years of Formal Schooling	.325	.36	.32	.34
Occupational Experience	.51	.49	.36	.44
Age	.22	.22	.16	.17
Arithmetic Achievement	.40	.37		

2. Negative relationships were found between the criterion for learn-

ing success and the following two variables investigated for the different-sized groups .The extent of these relationships is as follows:

Previous Courses in Bookkeeping or Accounting	—.26	—.10	—.21
Recency of Educational Experience		—.07	

In order that the net relationship between the several variables and the criterion might be determined, data were analyzed by the partial correlation technique. It was found that:

1. The factor of intelligence as measured by the General Classification Test is not, in and of itself, a significantly positive predictive measure for success in learning under the conditions of this study. As a predictive factor it is affected by schooling, occupational experience, and arithmetic achievement. Its net relationship to the criterion, after the factors of schooling, occupational experience, and arithmetic achievement are partialed out, is approximately one-third of its zero order coefficient of correlation relationship to the criterion.

2. The factor of Years of Formal Schooling is not, in and of itself, a significantly positive predictive measure for success in learning under the conditions of this study. As a predictive factor it is affected by intelligence, occupational experience, and arithmetic achievement. Its net relationship to the criterion, after the variables mentioned in the preceding sentence are partialed out, is approximately one-third of its zero order coefficient of correlation.

3. The Occupational Experience factor, in and of itself, gave the highest predictive measure for success in learning under the conditions of this study. As a predictive factor it is affected by intelligence, years of formal schooling, and arithmetic achievement. However, it provided the highest net coefficient of partial correlation with the criterion of any of the factors studied. It can therefore be said that occupational experience affords the best single predictive measure for success in learning although it is influenced by the other variables and must be considered in relation to them.

4. The factor of Age in relation to success in learning, under the conditions of this study, was found to have a net negative coefficient of partial correlation which approached zero. As a predictive factor it is somewhat affected by schooling, occupational experience, and arithmetic achievement. This is probably due to the fact that the other factors are concomitants of age and are not strictly separable from age.

The very small negative net correlation between age and the criterion, after the other variables studied were partialed out, emphasizes rather sharply that age, in and of itself, did not have a strong bearing on the success or failure of the men in this study, as judged by the criterion. The

men who were older obviously did as well as the men who were younger and, with the exception of those who were in the 17-18-19 year-old group, the younger men did as well as the older.

Insofar as the conditions of this investigation permitted, it was found that, given certain incentives, under an externally controlled environment, intelligence, years of formal schooling, occupational experience, and arithmetic achievement are all positive predictive factors in learning success. In and of themselves, however, each of these factors does not contribute significantly. It would appear that in order to judge learning ability from a predictive viewpoint the variables would have to be considered in relation to one another.

In summarizing, it would be well to emphasize that the results showed that age, in and of itself, under the learning conditions set forth in this investigation, had a very slight bearing on success or failure as determined by the criterion. This held particularly true for those men who fell between the age range of twenty through forty. This age range is wide enough to be of significance to those who work with adults and those who are interested in the problem of the learning ability of adults.

This finding, as stated in the preceding paragraph, is, in the opinion of this investigator, the significant contribution of this study. There are cultural factors in our social structure which make it imperative that education be considered as coextensive with life. Education is not a problem to be dealt with in terms of the years of formal education as now commonly conceived. Rather the problem is one of continuing education for democracy and education for economic efficiency through the adult years.

It would appear that adult education programs, in sofar as the learning ability of the student is concerned, can be just as efficiently administered and taught as are the accepted secondary and college level school programs. The conclusion may also be drawn, insofar as the conditions of this study are met, that vocational upgrading or vocational re-training programs may be effectively and efficiently conducted at least through the age of forty.

These findings, then, substantiate Thorndike's[1] conclusion, written eighteen years ago:

> In general, nobody under forty-five should restrain himself from trying to learn anything because of a belief or fear that he is too old to be able to learn it. Nor should he use that fear as an excuse for not learning anything which he ought to learn. . . . . In general, teachers of adults of age 25 to 45 should expect them to learn at nearly the same rate and in nearly the same manner as they would have learned the same thing at fifteen to twenty.

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1 Edward L. Thorndike, *Adult Learning*, p. 177. New York: The Macmillan Company, 1928.

Age was not a significant factor in the learning of 3134 men of varying ages and abilities under externally controlled enviromental conditions and with correspondingly equated and controlled incentives for learning.

EDITOR'S NOTE: The appendices have been omitted in this publication. Appendices appearing in the manuscript are as follows: A - Qualifications for Storekeepers; B - Daily Work Sheet; C - Personel Data Sheet; D - The Criterion Tests; E - Permanent Grade Records; F - Data Sheets for IBM Tabulation; G - Punched IBM Cards; H - Statistical Measures and Techniques.

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